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FOUNDED BY JAMES PLEASANT PARKER

INCORPORATING

THE INDEX OF OTOLARYNGOLOGY

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ANNALS
OF
OTOLOGY, RHINOLOGY
AND
LARYNGOLOGY

INCORPORATING THE INDEX OF OTOLARYNGOLOGY.

VOL. XXXV DECEMBER, 1926 No. 4

LXXI.

A CASE OF DOUBLE TWIST WITHOUT STRICTURE OF THE TERMINAL PORTION OF THE ESOPHAGUS.*

BY HARRIS P. MOSHER, M. D., Sc. D. (Univ. of Penn.),

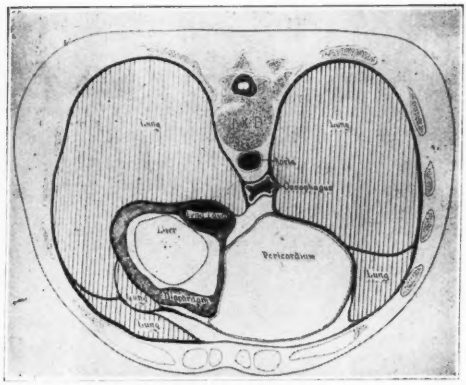
PROFESSOR OF LARYNGOLOGY, HARVARD MEDICAL SCHOOL,

BOSTON.

When, some four or five years ago, I first observed the action of the lung tips on the terminal portion of the esophagus, I received an appropriate thrill—to receive a thrill being the end and aim of present day existence. Since that time I have naturally watched their action. At times, however, I wondered if I was not making a little too much of them. In the case which I am to report today excessive action of the lung tips is the only discoverable etiology. This case sent me back to my anatomic specimens to review the anatomy. The result of this has been that I feel that I have not made as much of the lung tips as their anatomic relationship to the esophagus seems to justify.

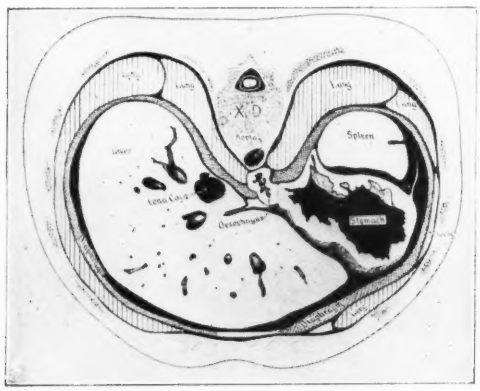
*Presented at the meeting of the American Bronchoscopic Society, Montreal, May 29, 1926.

Drawings not otherwise credited are by the writer; all radiograms taken by Dr. A. S. Macmillan, roentgenologist, Massachusetts Eye and Ear Infirmary.



—Drawn by Aiken.

Fig. 1. Transverse section of the chest at the ninth dorsal vertebra. The long axis of the esophagus is transverse. Notice the relation of the lungs to the esophagus.



—Drawn by Aiken.

Fig. 2. Transverse section of the chest at the tenth dorsal vertebra. The long axis of the esophagus has changed to anteroposterior. Notice the relation of the lungs to the esophagus.

The writer believes that the change in the long axis of the esophagus is due to the pressure of the basal lung tips.

A deflated lung tip is a shrunken, innocuous affair like a child's deflated squeaking balloon; inflated, however, it is another affair. The median surface of each lung shows a marked groove where the lung is in contact with the esophagus. This contact becomes more pronounced, until at the termination of the median surface of the lung, the lung tips surround the esophagus on three sides. The lung tip of the left inferior lobe varies greatly in size. It makes a thumblike projection,

Fig. 3. Illustration from Testut showing the relation of the basal lung tips to the terminal portion of the esophagus.
The left lung has a greater relationship than the right.

and it is free to move because the pulmonary ligament is not attached to it. The pulmonary ligament is really the mesentery of the lung and extends as a broad connective tissue sheet from the under surface of the bifurcation of the trachea and the under surface of each main bronchus as an apronlike sheet over the front face of the esophagus and between each lung as far down as the diaphragm. It is loosely attached to the front face of the esophagus. On the right it extends to the extreme lower limit of the lung—that is, to the lower limit of the right lung tip. On the left, however, it stops about an inch above the base of the lung and leaves the left lung tip free to move. The pericardium is in contact with the front face of the pulmonary ligament but is not glued to it opposite each lung tip. In other words, there is a large pocket between the pericardium and the pulmonary ligament which accommodates the left lung tip, and is the shape of the lung tip. On the right there is a similar pocket, which is smaller than that on the left,

but which, like the one on the left, corresponds to the shape of the lung tip. The lung tip on the right is smaller and in shape much like the horn of a Shorthorn bull. The left lung tip is larger and is concave anteriorly, very much like the palm of the hand. These two pockets nearly meet in the middle line. The pocket of the left lung tip extends to the inferior vena cava. It might easily extend in front of it. The right lung tip tends to go behind the esophagus, and the left lung tip tends to go in front of it. The left lung tip being the larger of the two, tends to twist the esophagus from right to left.

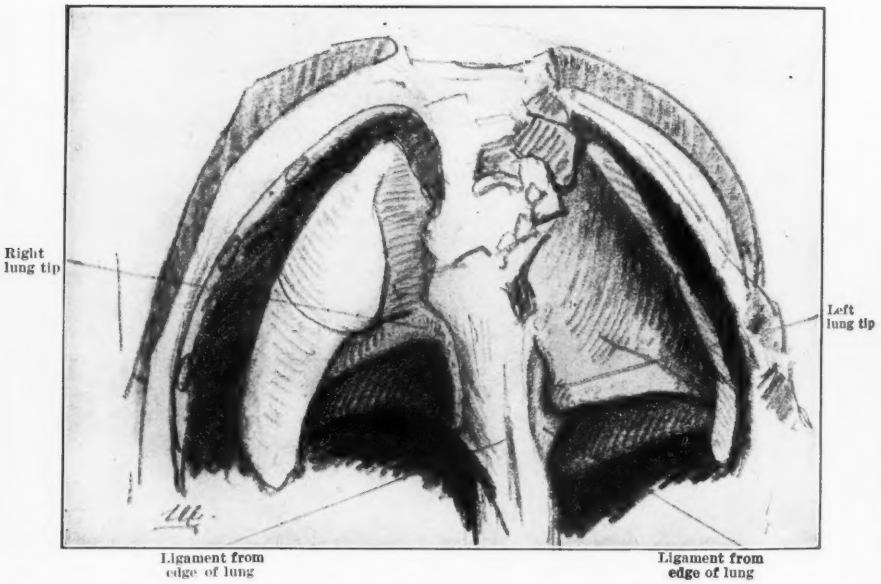


Fig. 4. Drawing from a term baby dead at birth, showing the striking difference between the basal lung tips of the right and left inferior lobes of the lungs.

The left basal lung tip is knob like and free from the ligament which runs from the lower medium edge of the left inferior lobe to the spine. On the right there is no such free process. The ligament to the spine from the lower median edge of the right lobe springs from the whole length of this edge.

Frozen sections of the thorax show that the main axis of the esophagus, until its terminal portion is reached, is transverse. When, however, the medium surfaces of the lungs and the extreme lower end of the esophagus come in close contact with it, and especially where the lung tips come in contact with it, the pressure of the lungs changes the lateral axis of the esophagus from transverse to anteroposterior.

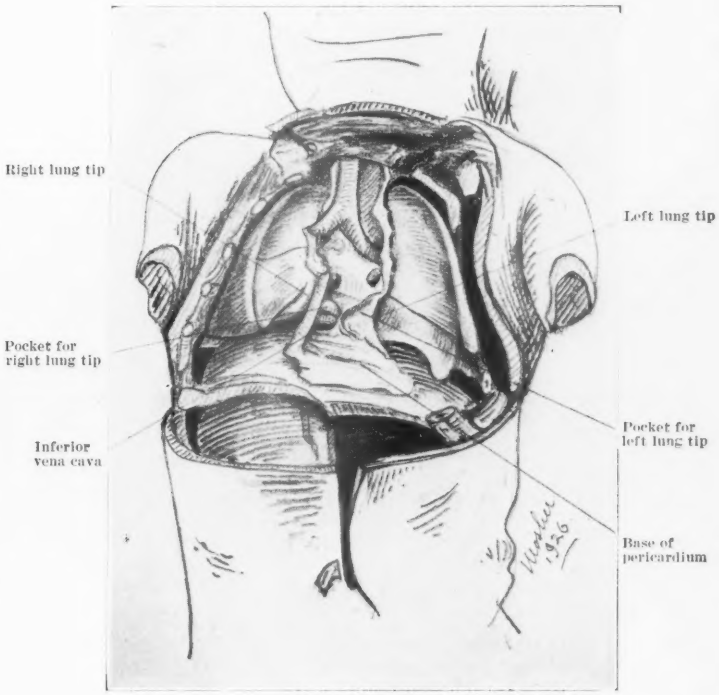


Fig. 5. Drawing from a term baby dead at birth. The front of the pericardium has been removed and the heart taken out. The posterior wall, the sides and the base of the pericardium are intact.

The drawing shows the pockets behind the pericardium into which the lung tips expand. Both pockets extend to the median line. The left pocket is much larger than the right.

The first two casts of the esophagus and the lungs which I have to show are made from a term baby dead at birth. They show this change in the axis of the esophagus very nicely. It will be noticed in the first cast that the lungs pinch the posterior half of the esophagus but that the anterior half is free. The second cast shows the impression made by the lung tips on the terminal portion of the esophagus. The hardened lungs were forced strongly against the esophagus, and the esophagus and the upper end of the spine bent slightly forward. With the bending of the spine there was a corresponding bend in the

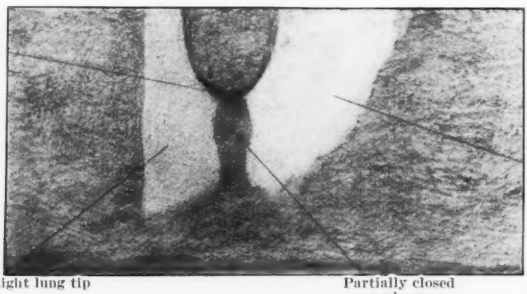


Fig. 6. Shows the lung tips inflated. Watched through the flouroscope the esophagus is seen to be momentarily occluded. Below the point of occlusion a clear gap is seen from half to three-quarters of an inch long.

A successful plate, however, shows that below the point of apparent occlusion the esophagus is narrowed but is still patent. This picture is due to the fact that the long axis of the esophagus is changed by the action of the lung tips from transverse to anteroposterior.

esophagus, which accentuated the bend made by the pressure of the left lung tip as it forced the esophagus against the right lung tip. Before the cast was made the left lung tip was pulled away in order that the kink which it produced in the esophagus would show. On examining the esophagus carefully it will be seen that the posterior half is compressed from side to side, and the anterior half, where the lung tips have free play, is turned from right to left, producing a marked kink. My conception of the action of the lung tips is that, when expanded, they constrict the anterior half of the esophagus; in other

words, the part which is anterior to the plane of the lung tips. Below the constriction caused by the pinching of the lung tips the posterior half of the esophagus, which is compressed by the median surfaces of the lung, is seen as a narrow ribbon running perpendicularly or slanting off to the left.

The two casts show that the pressure of the lung tips and the pressure of the median surfaces of the lungs from which these lung tips spring can between them obliterate the anterior half of the esophagus and cause it to twist to the right, and to

Fig. 7. Radiogram of the esophagus and stomach of a term baby dead at birth.

The esophagus and stomach are filled with barium. There is a spindle shaped dilatation of the esophagus above the cardia. This is normal and is due mostly to the constriction caused by the left crus as it passes behind the esophagus.

narrow the posterior half to a thin ribbon. It will be seen, therefore, from these cadaver experiments, judging them as conservatively as possible, that the lung tips are capable in certain cases of causing bends and twists of the esophagus.

The patient who brought the action of the lung tips strongly before me and led to this somewhat complicated review, clear

to me but which I feel is not so clear to you, is a woman in the uncertain fifties. She came to the hospital a living skeleton. She was eating everything, but vomited three or four times a day, or, as she put it, "threw up," and evidently was getting only just enough nourishment to exist. Her present trouble began twenty years ago and has continued to the present day. She has never had any chest or abdominal condition which

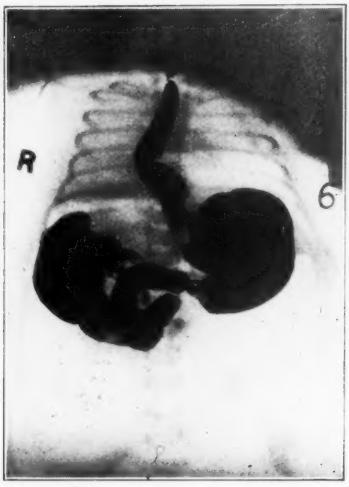
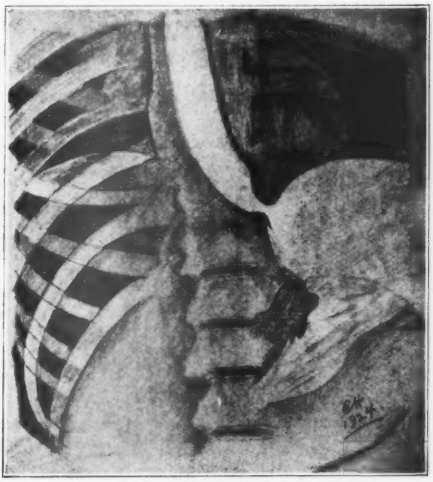


Fig. 8. Radiogram of a term baby dead at birth. The esophagus and stomach are filled with barium. The lungs were forcibly injected with air and the trachea occluded by tying. Upward pressure was made on the abdomen.

The film shows a very marked impression of the left lung tip on the terminal portion of the esophagus. The lower end of the esophagus is dilated, and at the upper limit of the dilatation the esophagus bends sharply to the right.

might be the cause of her trouble. She has never had any pain. When her trouble started she went to the hospital of the University of Pennsylvania and was there seven weeks. She was told she had chronic gastric catarrh. Her stomach was washed out daily, and she was given both bicarbonate of soda and acids. She left the hospital unimproved and for a year washed out her stomach herself once a day.

Fluoroscopic examination showed a double twist of the terminal portion of the esophagus. The lung tips were very active, and with each inflation the lower bend was pushed up beneath the upper bend. During the fluoroscopic examination, which lasted from ten to fifteen minutes, no barium was seen to enter the stomach. On account of the double twist of the esophagus I was doubtful whether I should be able to



—Drawn by Dr. Huyghebaert.

Fig. 9. Retouched X-ray tracing of the esophagus of an adult. The impression of the left lung tip on the esophagus is very marked.

get by the twist and find the opening into the stomach. Under ether, however, and with the aid of ballooning, the twist was passed and the opening into the stomach found far off to the left. The esophagoscope would not enter the stomach but a No. 20 bougie did. Passing the bougie was followed by no improvement, as the fluid level after the examination was the same as before, namely, at the level of the arch of the aorta. A gastrostomy was done. At the operation the surgeon was asked to examine especially about the fundus of the stomach and about the under surface of the liver for the presence of

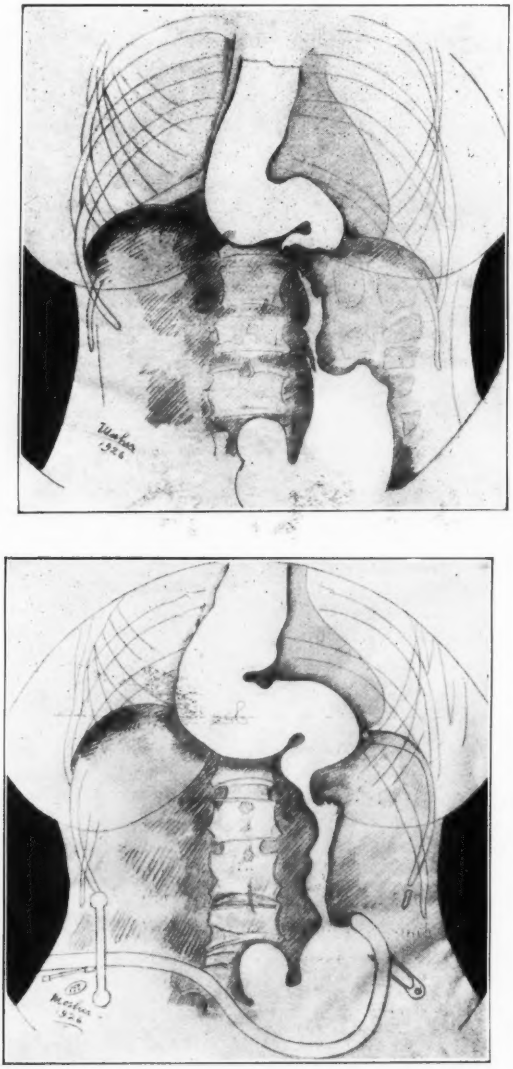


Fig. 10. Shows two tracings from X-ray plates taken after the second intubation. In the upper cut the diaphragm is down and the esophagus is closed. In the lower cut the diaphragm is up, and barium is pouring freely into the stomach. Before intubation and after passing bougies no barium was seen to pass into the stomach.

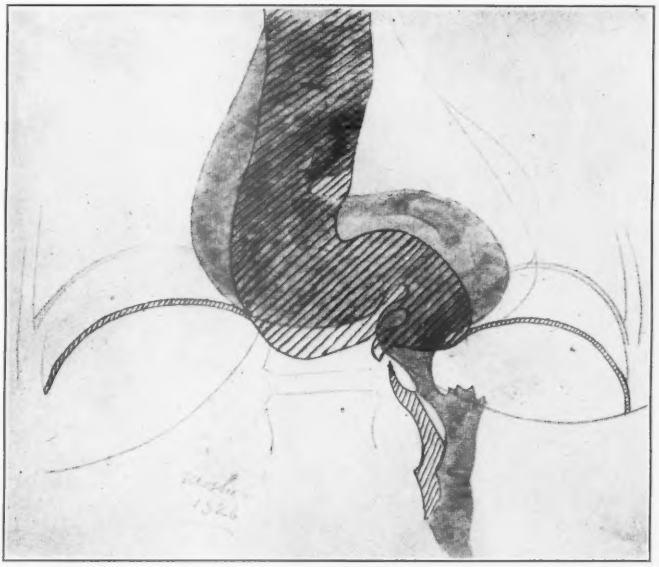


Fig. 11 shows two superimposed esophagus tracings from X-ray plates. The plates were taken after the second intubation. In one plate the diaphragm is down, in the other it is up. When the diaphragm is down the esophagus is closed. When the diaphragm is up the esophagus is closed. When the diaphragm is up the esophagus opened and the barium was discharged freely into the stomach. Before intubation nothing was seen to pass from the esophagus to the stomach.

The superimposed tracings show clearly the change in position of the terminal portion of the esophagus during inspiration and expiration, as well as its change in form.

bands and for thickening of the terminal portion of the esophagus. No pathologic condition was found. When the patient was sufficiently recovered and had returned to us she was given a string to swallow. After a number of misadventures with the string, it was kind enough to float onto the abdominal wall during one of the patient's feedings. With both ends of the string finally in our possession, retrograde bouginage was

Fig. 12. Natural size. Shows the first type of intubation tube.

tried, working easily up to the largest bougie (30 F.). Fluoroscopic examination after repeated bouginage showed that there was no increase in the ability of the esophagus to empty itself. The conclusion was reached that the obstruction was due to a bend or twist in the esophagus rather than to a stricture.

It was then decided to intube the lower end of the esophagus, hoping that by keeping the twist untwisted the esophagus might fix itself in its corrected position. The patient was intubed twice for a period of seven days each. The fluoroscope

showed that the tube would function. Castor oil put into the patient's stomach appeared in the patient's mouth. Further proof that the tube functioned. Although the tube was kept in for seven days at each trial, these days were anxious, because there was a certain amount of abdominal distress ac-

Fig. 13. Natural size. This figure shows the second type of intubation tube.

companied by vomiting of dark material two or three times a day. This proved to be blood. I now feel that the blood came from the string which was attached to the lower end of the tube and which had to be drawn tight on the abdominal wall in order to keep the tube from slipping up. At no time was the bleeding alarming, but my first thought was that the tube was

causing an ulceration in the esophagus. After the second intubation the fluoroscopic examination showed that fluid went fairly well from the esophagus into the stomach. The patient at the hospital was able to retain liquids, regurgitating only once or twice a day. The intubation, therefore, accomplished a certain amount of good.

Fig. 14. Rubber balloon designed for checking uterine hemorrhage. By means of the esophageal string which the patient was wearing the rubber bag was carried down the esophagus and the tube attached to it brought out of the gastric fistula. The bag was inflated and held so by a clamp on the projecting tube. The patient was given a little barium in order to coat the bag and make it show better. When the bag was inflated it was pulled down strongly by means of the tube. It was found that both bends of the esophagus straightened out, proving that there were no adhesions or bands to cause the twisting. (See Figs. 15 and 16.)

When this paper was first planned, the procedure of intubation for the relief of twist of the esophagus seemed to me to be the important part of it. At the present time, however, my perspective of the case has changed. The extent to which it has changed will come out later.

The third intubation was tried with an improved tube, but the tube came apart, the core coming out through the abdominal wall and the bulb of the tube being rescued from the esophagus by the retrograde passage of an olive.

I felt that I had reached the limit of my resources in this case, and it was summarized in my mind as follows: There was a double twist of the terminal portion of the esoph-

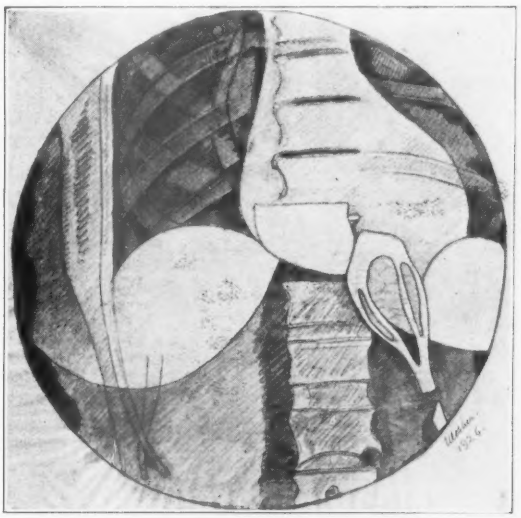


Fig. 15. Shows the inflated bag in place and pulled down as far as it would go. Both bends of the esophagus are obliterated. The plate was taken in deep expiration, that is, with the diaphragm up.

agus unassociated with stricture. It was possible, however, that one or more bands might be responsible for the twists.

After a night of defeat and despair, I thought of trying a rubber balloon in the esophagus. I had in my kit a rubber bag, which is used to dilate the cervix, and which I had bought hoping to demonstrate the normal twist of the esophagus. I had forgotten it but remembered it with joy, because it seemed to offer possibilities in this case. By means of the string—and,

by the way, without the string and the gastric opening I should never have gotten anywhere in this case—the bag was dragged down, stem first, the rubber tube which made the stem coming out onto the abdominal wall. When the bag was in place it was inflated and the patient was given a small amount of barium in order to coat the walls of the bag. The distended bag was then pulled upon, and it was found that the two twists

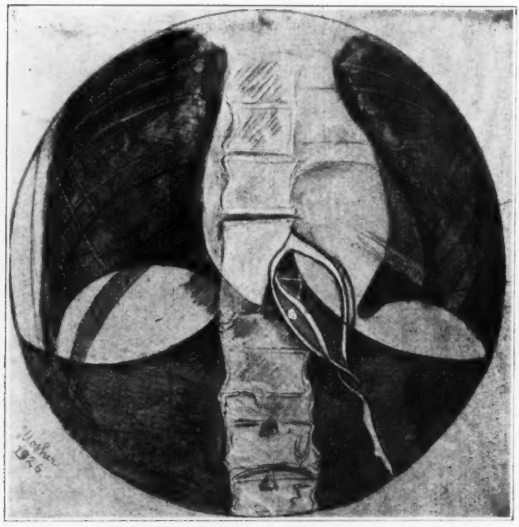


Fig. 16. Shows the inflated bag still in place. The plate was taken in full inspiration, that is, with the diaphragm down. Notice the deep notch in the upper border of the esophagus made by the inflated left lung tip.

of the esophagus straightened out, proving that there were no bands responsible for them. The bag also proved that at the point where the esophagus joins the stomach there were no strictures.

Another procedure which I had had in my mind previously came back to me. This was to fill a long rubber sausage with barium and to carry it from the esophagus into the stomach

and learn by X-ray of the bag in place the configuration of the esophagus. The apparatus was made as follows: A piece of fairly stiff rubber tubing, about three feet long, had numerous small holes punched in it along the middle two-thirds

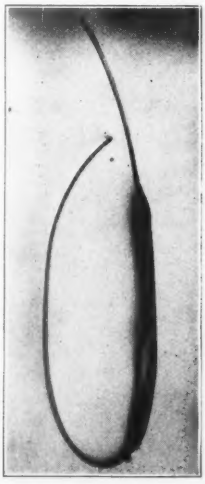


Fig. 17. Shows the apparatus improvised for determining the size of the lumen of the esophagus at the point where the esophagus joins the stomach. In other words it was designed to show the presence or absence of stricture at this point.

The apparatus is made of a piece of rubber tubing (20 French) about three feet long. The middle third of the tube has numerous small holes punched in it. Over the middle third and covering the holes a thin piece of rubber tubing such as is used to enclose gauze drains is placed and tied top and bottom. By clamping the lower end of the main tube, the main tube and the rubber balloon surrounding it can be filled with barium.

By means of the esophageal string the apparatus was carried into the esophagus and the lower end of the main tube brought out the gastric fistula. When the fluoroscope showed that the balloon was well in the stomach it was filled with barium.

of its length. A thin piece of rubber tubing, about an inch in diameter and about twelve inches long, was slipped over the rubber tubing and tied in place above and below the perforations. The short end of the tube was attached to the upper end of the string, which came out of the patient's mouth, and

the apparatus was carried down the esophagus into the stomach, the short end coming out through the opening into the stomach. The lower end of the tube was then clamped and barium was forced into the long end of the tube, which came out of the patient's mouth. Through the fluoroscope the bag was seen to fill satisfactorily, and one-half of it proved to be in the stomach and the other half in the esophagus. A plate was then taken, the patient being told to take a full breath and

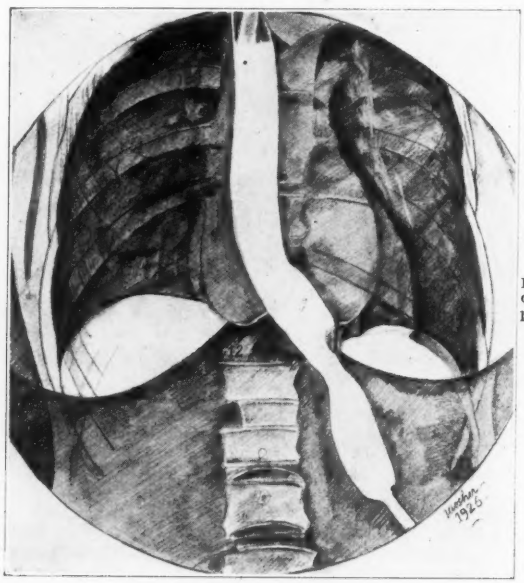


Fig. 18. Shows the sausage balloon in place. The plate was taken in full inspiration, that is, with the diaphragm down. The bends of the esophagus are obliterated as when the small balloon was used. There is no obstructing stricture at the lower end of the esophagus. There is a very deep notch in the esophagus caused by the inflated left lung tip.

The two pieces of apparatus just described furnish a method of differentiating between twists and strictures of the esophagus. Should a case present itself which did not demand immediate gastrostomy the sausage balloon might be passed by means of an obturator or stylet. Supposing the case proved to be one of twist, then an abdominal operation for its relief could be done in a clean field and the incision made at the usual point of election.

hold it. Two or three exposures were made and the plates were very satisfactory. The long bag showed the same thing which the short bag showed, namely, that the bends in the esophagus were easily reducible and not due to the presence of bands. The plates showed further that there was no stricture. Finally, they showed a very marked impression of the left lung tip.

Conclusions: Here evidently is a case of double twist of the terminal portion of the esophagus, not caused by bands and unassociated with stricture. The only etiology discoverable at the present time is excessive action of the lung tips, especially the left. The left crus is displaced downward one vertebra, allowing the left lung tip even greater play than usual. The fluoroscope shows excessive action of the lung tips, especially of the left. A review of the anatomy of the lung tips shows that they not only change the axis of the esophagus from transverse to anteroposterior, but they can twist the esophagus to the right. Resolving the twist by intubation restored the ability to swallow liquids. A better procedure in this case, on theoretical grounds, because it has never been tried so far as the writer knows, would be to enlarge the esophageal opening in the diaphragm, resolve the twist by pulling the redundant esophagus into the abdomen, mobilizing the stomach again and attaching the fundus of the stomach to the abdominal wall as low as is feasible.

In this case since the stomach is adherent to the abdominal wall owing to the presence of the gastric fistula, it would be necessary to operate at a distance from the original incision in order to free the stomach and to close the fistula. The presence of the fistula greatly increases the chance of infection. If it were possible in a similar case to establish the diagnosis of twist without resorting to a gastric fistula the case would be much simpler from a surgical standpoint. The writer is free to confess that he could not have managed this case without the gastric fistula and the esophageal string. Having proved that such a case as this can exist, in another case, the elongated balloon for establishing the diagnosis of twist and the use of a duodenal tube for feeding to prevent starvation might prevent the necessity of gastrostomy and allow the

abdominal procedures here advised to be carried out in a clean field.

828 Beacon St.

DISCUSSION.

Dr. Chamberlin: No one knows enough to discuss this subject. I shall have to beg Dr. Greene's pardon—I see he has something to say.

Dr. D. Crosby Greene, Boston: While I do not claim to know enough to discuss this paper as a whole intelligently, I should like to bring up one point in relation to the action of the lung tips. Dr. Mosher has shown beautifully by his studies and demonstrations that the lung tips come down and inwards in such a way as to suggest that they are a positive factor in producing a compression stenosis of the lower end of the esophagus. There can be no disputing the fact that they do come down in the manner he has described. But I question whether this expansion of the lung in this region can be regarded as exerting a positive pressure on the esophagus. The lungs become inflated by negative pressure as the pleural cavity is enlarged by the respiratory muscles. I believe we must look for an explanation of the phenomenon which he has demonstrated to muscular action outside the pleural cavity which enlarges the pleural cavity next to the esophagus and which permits expansion of the lung in this region.

Dr. M. C. Myerson, Brooklyn: I have nothing to say about the lung tips. In Lilienthal's "Thoracic Surgery," in the section on the esophagus, a case is reported where the esophagus was pulled down into the abdomen and the lower end of the remaining esophagus was united to the stomach.

Dr. H. P. Mosher (closing): It is very seldom that Dr. Greene and I disagree so frankly in public. If you do not see that there is positive pressure from the inflated lung, your idea of physics is queer. I wish that we could get the esophagus empty, but we cannot. Dr. Myerson's report of Lilienthal's case is very interesting.

LXXII.

BEADS AS FOREIGN BODIES IN THE BRONCHI—MECHANICAL PROBLEMS PRESENTED AND THEIR SOLUTION.

ELLEN J. PATTERSON, M. D.,

PITTSBURGH.

Beads as foreign bodies in the bronchi present difficult mechanical problems for their safe removal. The problem is quite varied, chiefly because of the great variety in the shape, size and character of the beads in use at the present time.

From early childhood, children are encouraged to regard beads as playthings; the abacus frequently found in the fence of the "kiddy coop" is made of beads strung on wires.

Beads are used as kindergarten material, probably because of the attractive colors and ease with which children can be taught to string them, thus learning to count as well as sew.

From early infancy, children are presented with strings of beads to ward off evil spirits, croup and other diseases.

The surprising fact is that we do not encounter beads as foreign bodies even more frequently.

Pathology.—Beads may be organic or inorganic. They may be amber, Job's tears (coix lacryma Jobi), wooden, ivory, bone, glass, metal or composition. They vary greatly in shape and may be spherical, pyriform, conoidal, oval, rectangular or a combination of two forms.

A glass bead causes little or no pathologic change in the lung other than obstruction. Jackson[1] says: "Glass, if smooth and free from sharp edges, seems to produce little reaction unless it corks a bronchus. The slight and strictly localized reaction of glass has been noticed in many instances of glass headed pins." The hole in a bead may delay the development of pathology by permitting a degree of ventilation and drainage.

Etiology.—The accident usually occurs when a child, playing with beads, places one bead in the mouth and accidentally inspires it. The inspiration may be contributed to by any of

the general causes enumerated by Jackson,[2] running, jumping, laughing and especially the movements followed by deep inspiration, such as coughing, choking, etc.

Symptomatology and Diagnosis.—The symptoms resulting from the inspiration of the bead depend upon the shape, size and composition of the bead, as well as its location in the tracheobronchial tree. A round bead may turn in any direction so that the air may pass through the hole in the bead or it may block the passage of air and give rise to signs of obstruction, or by intermittent obstruction it may have a valve like effect, producing obstructive emphysema or atelectasis alternately or obstructive emphysema in one lobe and obstructive atelectasis in another.

A bead with one diameter longer than the other will usually lie in the long axis of the bronchus, allowing air to pass through the hole in the bead, causing no obstructive symptoms.

A bead freely movable in the trachea will give the characteristic symptom, the "asthmatoid wheeze,"[3] and, if hitting against the under surface of the glottis, the "audible slap" and "palpatory thud." If it lies at the bifurcation it may cause obstructive symptoms of both bronchi with dyspnea and cyanosis. If fixed in a bronchus, the physical signs may be slight, except limited expansion. The bead may be coughed out of one bronchus and be reinspired into the other, as occurred in a case reported by Patterson[4] in 1923.

Mechanical Problems.—The problem of removal of the bead from a bronchus varies greatly with the size, shape, surface qualities, as well as with the degree of impaction and duration of sojourn.

To get a secure grasp on a spherical (Fig. 1 A) or spheroid bead, whether rough or smooth, the forceps blades must be applied beyond the equator.

Pyriform, oval, squared or conoidal beads (Fig. 1 B, C, D and E), must have the forceps blades applied beyond the minor axis of the ellipsoid or base of the conoid,[5] as the case may be, to get a secure grasp. The long proximal taper on a pyriform bead is particularly difficult to hold, unless the just mentioned advice be followed.

The hole in the bead, especially when visible endoscopically, presents a great temptation to use it as a means of extraction.

It has been so used by a number of bronchoscopists, and I have tried it on one case.[6] An instrument to slip through the hole in the bead and open on the distal end, with teeth to prevent the bead slipping off, works perfectly in theory, but practically it is disappointing, as the holes in beads are not uniform, and it may be dangerous unless used with the utmost care.

A study of the presentation from the radiograms and endoscopically is important, though in the case of a square sided oval bead it is not always possible to determine endoscopically from the presenting part the position of the flattened sides.

Fundamental in the endoscopic removal of this class of foreign bodies is the forceps spaces, which is the name Jackson[7] has given to the spaces between the foreign body and the wall of the invaded bronchus, into which the jaws of the forceps must go before they can grasp the bead.

The correctly constructed forceps to grasp a bead must have the planes of the grasping forceps parallel instead of divergent, otherwise the grasp is insufficient and the bead will be stripped out of the forceps, and it is better if the distal ends bend slightly toward each other. Serrations in the cups and properly canted are essential. This correct type of forceps is found in the Tucker bead forceps.

Each case should be studied with a duplicate bead upon a mannikin before any attempt is made at removal from the living patient.

Case Report.—Many of the phases of the bead problem are illustrated by the following case report:

R. C., a well developed boy, aged 4 years, was referred to me by Dr. G. A. Anderson, of Barnesboro, Pa., December 12, 1925, with a history of having inspired a bead the previous evening, December 11, 1925. The child was playing with a string of beads, and while running about with a large bead in the mouth he choked and coughed. The coughing continued for two hours, after which he slept quietly for five hours, and upon rising in the morning he had no cough but breathed heavily.

While on the road to the hospital, the child had a paroxysm of coughing and some cyanosis, after which he had the typical "asthmatoid wheeze."

Upon admission to the hospital, Dr. C. W. Morton made a physical examination and reported that there was evidently a foreign body in the trachea, acting as a partial obstruction to respiration.

At bronchoscopy, without anesthesia, the bead was found just entering the right bronchus and, seizing it with Jackson's strong expanding spring forceps, I withdrew to the glottis, where the bead was stripped off and rapidly receded again into the right bronchus.

Two attempts were made later to remove the bead with other forceps, but both were unsuccessful. I could grasp the bead, but after withdrawing a short distance the forceps would slip and the bead would recede down the bronchus.

January 5, 1926, Dr. G. W. Grier reported, after X-ray examination, that there was a bead, oval in shape, lying in the right main stem bronchus (Fig. 2), with the hole through the bead parallel with the bronchus and no evidence of pathology in the lung other than the foreign body.

January 7, 1926. At bronchoscopy, without anesthesia, with Tucker bead forceps, I removed the bead (Fig. 3), and four days later the child was discharged well.

Comment: The difficulties in this case were due to the large size, the shape, rectangular with round ends, and the extreme hardness and smoothness of the surface of the bead.

In order to get sufficient spread of the forceps blades to get over the bead, I had to advance the bronchoscope to the foreign body, touch the bead with closed forceps, withdraw the bronchoscope the length of the forceps blades and then open and at the same time advance the forceps blades into forceps spaces.

The bead was so long and smooth it was necessary to advance the forceps, not only to, but beyond the largest diameter of the bead, otherwise the blades slipped off, due to smoothness of the bead and negative pressure in the bronchus.

The forceps blades, when spread sufficiently to grasp the wide bead, also spread the bronchial wall, and this allowed the bead to recede farther down the bronchus, and instead of the blades closing down upon the bead they merely grasped the end and readily slipped off.

The problem was finally solved by using the Tucker bead forceps with parallel blades, which opened sufficiently to ad-

vance in the forceps spaces, embrace the bead and hold securely for removal.

Prophylaxis.—Beads strung on wire are safe, but beads loose or strung on string, dental floss, silk or light chains are dangerous.

The running of this child with a bead in his mouth as the chief cause of the accident illustrates the importance of the classification of etiologic factors by Jackson.[8] Children should be taught, not only to avoid putting inedible substances in the mouth, but to avoid running with anything, even food, in the mouth.

Dr. Jackson and I, many years ago, removed a piece of anthracite coal from the bronchus of a Marathon racer, who had accidentally inspired it during a race.

Our records contain many instances of children inspirating foreign bodies while running.

As mentioned by Jackson,[9] a string of beads, as well as one or more loose beads, is a dangerous plaything for children.

Mothers, nurses, kindergarten teachers and others should be instructed as to the danger of using loose beads or weakly strung beads for either playthings or instructional apparatus. For the latter purpose the wire strung frame seems the safest form.

CONCLUSIONS.

1. The inspiration of beads into the bronchi are preventable accidents and should be eliminated by prophylactic propaganda.
2. The reaction due to beads in the bronchi depends upon the character of the bead and whether or not it is obstructing a bronchus. Glass beads produce little reaction.
3. Each bead problem should be worked out upon a mannikin before any attempt is made at removal from the living patient.
4. To get a secure grasp, spherical beads must have the forceps blades applied beyond the equator; and pyriform or oval beads must have the forceps blades applied beyond the minor axis of the ellipsoid.
5. The Tucker bead forceps with the planes of the grasping surfaces parallel is the most efficient forceps for the removal of beads from the bronchi.

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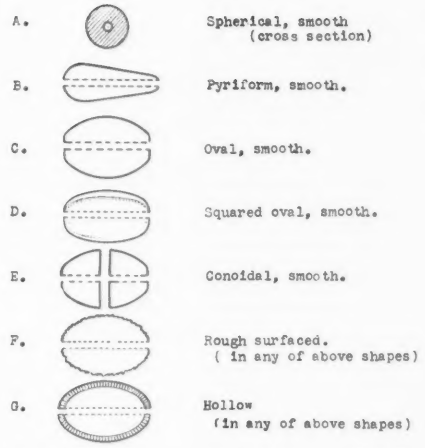

Fig. 1. A, Spherical bead must have blades applied beyond equator. B, Pyriform. C, Oval. D, Oval squared (author's bead). E, Conoidal, must have blades applied beyond the minor axis of ellipsoid or base of conoid. F, Rough beads are more easily grasped on account of rough surface. G, Hollow beads require the same technic.

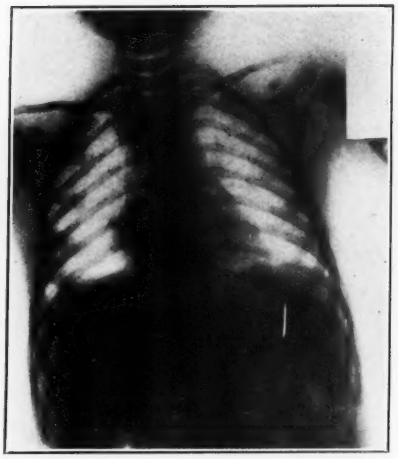

Fig. 2. Radiogram showing oval bead in right bronchus, with long axis of bead parallel to axis of bronchus.

Fig. 3. Glass bead removed from right bronchus.

DISCUSSION.

Dr. E. Lee Myers, St. Louis: I wish to recite an experience I had which is a distinct lesson. When a child tells you he has aspirated a bead or piece of glass the problem is very difficult. One case of this kind came to Dr. Payne, in which the child had had a glass bead in his mouth and was not sure what became of it. I did not know how best to proceed. I spent twenty cents buying all kinds of beads and tried them out on the dog. I also worked with glass, and it seemed as if I had a plate glass window 9 by 12 feet in the lung; I could not surround it. The boy now told me he had a piece of glass from an automobile windshield; so then I went round getting green glass, and figured it out with pieces of different angles. I tried it on the boy, but had another failure, though it worked well on the dog. I then had a stereoscopic picture made and found I was confronted with quite a problem, on account of the various angles. It seemed like part of a circle of which one end was a prism. We had to do three bronchoscopies. I worked with my associate and we had to dilate a stricture above the glass. We finally got this foreign body out with meat forceps. This is a very practical instrument and should be kept in mind in these cases.

Dr. R. L. Moorhead, Brooklyn: I think that anything that throws light on the bead problem is of interest. I had one very difficult case with a bead, similar to this one reported. I used the forceps and got hold of it well, but lost it, and it slipped out of the forceps half a dozen times. It is very difficult, when the bead is tightly imbedded, to get forceps spaces. If you do not have sufficient grasp, you are acting on a wedge, and simply pushing the foreign body further away. I think these Tucker forceps should help a great deal in these cases.

Dr. S. Yankauer, New York: I have met with this problem and have spent quite a number of days trying to solve it. I want to call attention to the value of the hook for the removal of some beads, especially those where the hole goes through the short diameter of the bead. The hook need not be completely bent, but should be bent at a little more than right angles. You can secure the bead, even when the bead is wedged in the walls of the bronchi. You can rotate the bead

and get the hook into the hole and withdraw it upwards in that way and you will not lose it.

Dr. Cunningham, Vancouver: I would suggest the same means as Dr. Yankauer. I think an apparatus with a brace to close the hook might have brought it up.

Dr. Wm. B. Chamberlin, Cleveland: I have found it an advantage to have in my armamentarium a stiff wire and a pair of pliers, with which to make a hook. One should always have a handle upon this wire, bent in exactly the opposite direction to this hook, or one might get the hook engaged in the wall of the bronchus and not know in which direction the hook was turned. It is also of advantage to have the hook bent at a little less than a right angle. If it is bent at more than a right angle it may engage the wall of the bronchus and is difficult to disengage.

Dr. M. C. Myerson, Brooklyn: There are times when it would be well for the bronchoscopist to disregard the use of the bronchoscope in this type of case. Judgment should be governed by the age of the child, by the duration of the sojourn of the foreign body and the amount of local reaction. I have had two cases where tracheotomy was the procedure of choice. Another governing factor would be the type of forceps which the individual operator has at hand at the time of the emergency. When the child has had a bead flapping to and fro in the trachea, with considerable laryngeal trauma, if you are not certain that a first rapid attempt will extract the bead, I think the better method is the performance of a tracheotomy and the picking out of the bead with a pair of thumb forceps. This type of case will require tracheotomy after bronchoscopy as a rule. These children invariably set up a tracheobronchitis, which looks like bronchopneumonia. There is less trauma with tracheotomy. There is certainly better drainage and recovery is not delayed.

Dr. H. H. Forbes, New York: I have only run across one case of a round bead. The only tip I had at the time was the three pronged instrument. This type of instrument is supposed to be used for cork. Two of the prongs entered the two holes in the bead. It didn't take me half a minute to remove it. I just happened to grasp the bead at the two vital spots.

It is curious how one instrument will help one operator and not another. Perhaps in my next case I shall not be so lucky.

Dr. R. A. Mercer, Detroit (by invitation): There are some paper beads on the market, a long oval in shape. They are very difficult to remove. I took a long piece of ordinary brass tube, with a No. 6 piano wire, one end of which was soldered into the tube. This was doubled and passed through the bead, and then a sharp kink was made at the further end of the bead by pulling on the other end of the wire, passed down to the proximal end of the tube. I could not move the bead, so then I kinked the wire tighter, and pulled the wire through the bead. I pulled some of the paper out and the patient breathed better. Shortly after this the patient came down with scarlet fever and was sent to the hospital. He had rather a troublesome cough, and when he came out of the hospital he coughed up the rest of the bead. That method worked on the paper bead, but I do not know whether it would work on another type.

Dr. E. McGinnis, Chicago: A fellow worker of mine has an ingenious instrument that takes advantage of the fact that a bead has a hole in it. Mr. Mueller made an instrument from this design. It is a fine tube with a slit made in one side. A piano wire is inserted, with a right angle hook. If this is in a certain position you can pass the instrument through the opening in the bead, then twist the right angle hook and you can get beyond the bead with it and it will come out easily. It does not catch on the bronchial mucosa.

Dr. Ellen Patterson, Pittsburgh (closing): I have tried various types of instruments that are put through the hole in the bead. I have an instrument with two slender wires with the ends turned outward to open with the teeth outward at the proximal end of the bead. The difficulty is that the holes in the beads are not uniform in size. I think hooks should be used with great caution in the bronchi on account of the danger of perforating the bronchial wall. The surface of this bead was so hard and smooth that it was difficult to grasp it. The tendency was for the bead to slip out of the forceps and go farther down the bronchus.

LXXIII.

FOREIGN BODIES IN THE ESOPHAGUS.*

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The clinical recognition of foreign bodies in the food passages is now of common occurrence, and removal by peroral esoghagoscopy is generally accepted as the only safe method. However, overlooked cases continue to come to the Bronchoscopic Clinic, and, now and again, a patient is brought in after ineffective efforts have been made at removal of an esophageal foreign body by blind and antiquated methods. In reviewing the histories of overlooked cases of foreign bodies one finds that the chief causes for the diagnostic errors are contained in the categorical list suggested by Chevalier Jackson.[1]

The cases reported herein have been selected from a personal series numbering over 200 and present some of the common problems in diagnosis, the signs and symptoms of which may be erroneously interpreted, and the solution of some of the problems involved in the removal of the foreign objects.

A history of choking, gagging or coughing while holding an object in the mouth is always suggestive of foreign body. If occurring in the case of a child while playing on the floor, it should always be considered as prima facie evidence of foreign body in the air or food passages and calls for careful investigation to determine its presence or absence. A negative roentgenologic opinion of opaque foreign body in the alimentary canal cannot be given unless the studies included the entire food passages, from the nasopharynx to the tuberosities of the ischium, inclusive.

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*Read at the meeting of the American Bronchoscopic Society, held at Montreal, May 20, 1926.

†From the Chevalier Jackson Bronchoscopic Clinic, Philadelphia, Pa.

Case No. 1.—A child, aged 16 months, was found choking and gagging while playing on the floor. Digital examination of the mouth and throat by the mother at the time of the accident, and later by a physician who was called, failed to reveal a foreign body. A roentgen ray study made at the Bronchoscopic Clinic showed the foreign object in the nasopharynx (Fig. 1), from which locality it was removed by direct methods.

Points of interest: Initial symptoms while playing on the floor. Ill advised digital manipulations. Importance of complete roentgen ray study.

Coins as foreign bodies are frequently found in the food passages, especially in children. In a series of 183 cases of coins at the Chevalier Jackson Bronchoscopic Clinic, which includes a personal group of 43 cases, the foreign bodies were found in the esophagus in 181 instances, the remaining two being found in the trachea and in the right bronchus, respectively. Here again must be emphasized the importance of a careful roentgen ray study before, as well as after, removal of the foreign body. Unsuspected multiplicity of foreign bodies and the failure to take an after-ray following esophagoscopic removal of one foreign body, might lead to considerable embarrassment.

Case No. 2, Six Cents in Esophagus.—Child, aged 8 months, while playing with a nickel and penny which he had put in his mouth began to choke, gag and vomit(?). A single roentgenogram, taken within a few hours after the accident, showed a disclike shadow at the root of the neck. He was sent to the Bronchoscopic Clinic, where anteroposterior and lateral roentgen ray films were made (Fig. 2). The coins were removed by esphagoscopy and the after-ray was negative for additional foreign bodies.

Points of interest: Importance of initial symptoms. Tendency to consider regurgitation as vomiting, which may lead to a diagnosis of stomach trouble. Necessity of making lateral and anteroposterior X-ray films as well as any additional roentgen ray studies which may be required.

Multiplicity of foreign bodies must always be thought of, especially when the objects swallowed are nonopaque to the roentgen ray.

Case No. 3.—A nurse came to the Bronchoscopic Clinic complaining of inability to swallow, and stated that four days before, while eating, she had swallowed a chicken bone. Following this accident there was noted a sticking sensation, which she referred to the front of the neck, opposite the suprasternal notch. Roentgen ray study, with the aid of a swallowed mixture of bismuth subnitrate, revealed practically complete obstruction of the esophagus at the level of the suprasternal notch. At esophagoscopy there were removed several grape skins, some string beans and finally a triangular piece of bone resembling part of the breast bone of a chicken (Fig. 3). The patient was able to drink water without difficulty immediately after the esophagoscopy.

Point of interest: Testing of swallowing function immediately after removal of the foreign body.

In the event that no opaque foreign body can be demonstrated by roentgenoscopy to account for symptoms referable to the esophagus which followed a definite choking attack while holding an object in the mouth, the roentgenologist should always employ a radiopaque material. This, when swallowed in solution or in capsule, will give data bearing on the swallowing function, and often will show the foreign body in silhouette or interference with the passage of the swallowed material.

Case No. 4, Button in Esophagus.—A child, aged 1 year, had difficulty in swallowing. There was a definite history of choking while playing with some buttons 22 days before admission to the Bronchoscopic Clinic. Immediately after the accident an X-ray examination was made, and a negative opinion for foreign body was given. The following day a physician passed a bougie, which was said to have traversed the entire length of the esophagus without meeting any obstruction. A second negative opinion for foreign body was given, in spite of the fact that the child could not swallow solid food and experienced difficulty with liquids. On admission to the Jefferson Hospital, Dr. W. F. Manges made a roentgen ray study of the esophagus, using a bismuth mixture. This revealed a foreign object in the esophagus (Fig. 4). A button was removed by esophagoscopy and the patient made an uneventful recovery.

Points in diagnosis: Difficulty in swallowing is the most common symptom of esophageal disease and calls for roentgen ray study and a diagnostic esophagoscopy when indicated. The bougie gives no conclusive information, irrespective of its being successfully passed or its meeting with an obstruction. A negative roentgen ray opinion on foreign body in the esophagus cannot be given until after a radiopaque mixture has been used. If symptoms persist in the presence of a negative X-ray opinion, esophagoscopy is indicated.

Complete obstruction of the esophagus may result from disease of the esophagus or periesophageal structures, from lodgment of a small portion of food or other substance in a lumen narrowed by disease or injury, or it may occur when a large swallowed foreign body completely occludes an otherwise normal esophagus. The latter was observed in the following case:

Case No. 5, Pecan Nut in Esophagus.—Man, aged 32 years, an inmate of a psychiatric institution, had previously attempted suicide and therefore did not attract much attention when he refused food. It was observed, however, that he would not swallow his saliva, and on questioning him it was learned that he had swallowed a large nut. A roentgenogram of the neck and chest was negative for opaque foreign body, so he was given a bismuth mixture to swallow, which, when observed fluoroscopically, showed complete obstruction of the esophagus at the level of the suprasternal notch (Fig. 5). By mirror examination of the laryngopharynx, both pyriform sinuses were seen to be completely filled with secretion (Chevalier Jackson's sign of complete stenosis of the esophagus). At the Bronchoscopic Clinic a large pecan was removed from the esophagus (Fig. 6). The large Forbes esophageal speculum and a specially devised alligator forceps were found very useful in solving a mechanical problem, which was rendered difficult because of the large size, conoidal shape and smoothness of the foreign body.

Points of interest: Inability to swallow saliva and finding of pyriform sinuses filled with secretion, indicating complete stenosis of esophagus. Mechanical difficulties in maintaining a firm grasp on smooth conoid shaped foreign bodies.

Pain as a symptom of esophageal foreign body may be produced by impaction of a large object, by penetration of the esophageal wall or by secondary inflammation. It usually cannot be relied upon as a means of localization of the foreign object (Jackson). This was well demonstrated by the following case:

Case No. 6, Toothplate in Esophagus.—Man, aged 42 years, accidentally swallowed a defective denture, which lodged at the level of the suprasternal notch (Fig. 7). Although there was difficulty in swallowing foods and slight tenderness could be elicited on deep pressure over the front of the neck at the level of the suprasternal notch, the patient complained of a sharp pain, which he localized at a point about one inch to the left of the midline on a level with the base of the ensiform cartilage. This disappeared completely following esophagoscopic removal of the denture.

Point of interest: Unusual localization of symptom of pain, which might be very misleading.

Esophageal foreign bodies may not only interfere with the swallowing function, but, because of their shape, size or other characters, may give rise to signs and symptoms referable to the air passages. In the following case dyspnea was an alarming symptom.

Case No. 7, Jackstone in Esophagus.—Child, aged 2 years, had choked on a jackstone five hours before admission to the Bronchoscopic Clinic. There was slight dyspnea present, which became quite alarming when the patient cried or struggled. This could be accounted for by the deviation and compression of the trachea demonstrated by Dr. Henry K. Pancoast on roentgen ray examination (Fig. 8). The foreign body was removed by esophagoscopy, using the Jackson laryngeal cup forceps and the Forbes esophageal speculum. The child made an uneventful recovery.

Tacks and other small foreign bodies usually do not lodge in the esophagus; however, when this does occur, as observed in the following case, there is commonly penetration of the esophageal wall with a variable degree of periesophageal infection.

Case No. 8.—Child, aged 19 months, developed dysphagia and became very irritable, fretful and dyspneic after choking

on a thumb tack. The patient was brought to the Bronchoscopic Clinic, and Dr. W. F. Manges, by roentgen ray examination, demonstrated the foreign body as well as the presence of marked swelling of the retropharyngeal tissues which compressed the trachea. (Fig. 9.) The tack was removed by esophagoscopy within 24 hours after the occurrence of the accident. Dyspnea with some dysphagia persisted, and for a time opening of the retropharyngeal mass as well as tracheotomy were believed necessary; however, after a number of days the inflammatory process subsided and surgical intervention was not required.

Prolonged sojourn in the esophagus of large, irregularly shaped objects may lead to considerable tissue destruction, the result of pressure necrosis. This may be so extensive as to penetrate the esophageal wall and perforate adjoining viscera.

Case No. 9.—The following case, child aged 3½ years, was brought to the Bronchoscopic Clinic because of marked dysphagia and weight loss. One month before admission the child choked while holding a jackstone in its mouth. Radiographic study revealed a jackstone in the cervical esophagus, with flattening of the trachea, marked periesophageal swelling and probable penetration of the party wall by one of the points of the foreign body (Fig. 10). At esophagoscopy, the patient became very dyspneic, so a 4 mm. bronchoscope, which had been gotten ready for such an emergency, was introduced into the trachea and tracheotomy was performed. Following this, esophagoscopic removal of the jackstone was accomplished. At bronchoscopy one of the points of the jackstone was found projecting into the tracheal lumen, being almost completely hidden by masses of granulation tissue. It had penetrated the party wall about 1 centimeter below the cricoid cartilage. The patient was eventually decannulated and left the hospital perfectly well twenty-four days after esophagoscopic removal of the foreign body. The difficulties in removal of the jackstone were greatly increased not only by the perforation of the party wall anteriorly but also because of a penetration of the posterior esophageal wall produced by a point of the foreign body directly opposite the esophagotracheal fistula.

Points of interest: Symptoms referable to the air passages in cases of esophageal foreign bodies. Penetration of esopha-

geal wall from pressure necrosis. Danger of asphyxiation from tracheal compression when removal is attempted.

The most common contributing factor in the etiology of foreign body accidents is carelessness (Jackson). The following case represents an unusual form of accident and is also the youngest patient in the writer's series of foreign body cases.

Case No. 10.—When 16 days of age, this little patient swallowed an open safety pin, which had accidentally dropped into its open mouth. While dressing the child, the mother stuck some open safety pins in the front of her dress. On bending forward, one of these fell into the crying child's open mouth. There was immediate choking and gagging, which soon subsided, so it was believed that the pin had been swallowed and would pass. After several days of waiting a radiograph was made, which showed the open safety pin in the esophagus. The patient was admitted to the Bronchoscopic Clinic five days after the occurrence of the accident, and the position of the pin verified by roentgen ray study (Fig. 11). It was removed at esophagoscopy by the dangling method.[2]

Points of interest: Frequency of foreign body accidents occurring in the very young who are, by themselves, unable to obtain foreign bodies. Every foreign body case should have the benefit of a roentgen ray examination, even if it is believed that the foreign body has passed spontaneously into the stomach and is expected to pass.

Open safety pins in the esophagus are practically always found with the pointed extremity uppermost. Occasionally a case is observed where the pin is in the esophagus, point and keeper down and spring uppermost. In Jackson's case, a child, aged 12 months, the open safety pin had been observed by fluoroscopy in the stomach for seven weeks. At this time an attack of vomiting caused the pin to be regurgitated into the thoracic esophagus, where it was located by roentgen ray study. A second vomiting attack carried it to a higher level. The patient was immediately brought to the Bronchoscopic Clinic and the pin removed by esophagoscopy. At the time of operation the temperature of the patient was 105.8°. After removal of the pin the temperature soon returned to normal and remained there.

Case No. 11.—The following case, a child aged 4 months, came under our observation at the Bronchoscopic Clinic, six days after swallowing an open safety pin. The patient seemed perfectly comfortable following the accident, so nothing was done until the fifth day, when, not having recovered the pin in the bowel movements, it was decided to have an X-ray examination made. This showed an open safety pin, pointed extremity down, in the thoracic esophagus. These findings were verified on the following day at the Bronchoscopic Clinic (Fig. 12). The pin was removed by peroral esophagoscopy, using a rotation forceps on the spring extremity. The child made an uneventful recovery.

Comment: It is very probable that the pin originally passed into the stomach and was later vomited, lodging in the thoracic esophagus. Any attempt to push the pin into the stomach would undoubtedly have resulted in a fatality. Introduction of the esophagoscope with the aid of a mandarin might have caused overriding of the foreign body.

One of the common errors leading to mistakes in diagnosis and prognosis in foreign body cases is failure to use the roentgen ray. Too often the absence of symptoms following a foreign body accident leads to the inference that the object has been swallowed and will pass spontaneously. Especially is this true if the size and shape of the foreign body are such that it could be readily swallowed. While this inferential deduction may be correct in many cases, it should always be fortified by objective data secured by roentgen ray examination.

Case No. 12.—In the following case, a girl, aged 11 years, who had swallowed a pencil ferrule, the inferential diagnosis of foreign body in the alimentary tract was correct. The conclusion that a foreign body of this shape should pass spontaneously was erroneous. After waiting seven days, an X-ray examination showed the object in the esophagus immediately above the diaphragm. (Fig. 13.) The patient was practically free from symptoms, only occasionally having a slight sensation referable to the epigastrium when swallowing solid food. The ferrule was removed by peroral esophagoscopy.

Points of interest: The point of lodgment of this foreign body is an unusual one. A foreign body of this shape should

ordinarily enter the stomach from this position, especially when solid food is eaten. Following removal of the object the esophagus seemed normal anatomically and functionally.

CONCLUSIONS.

1. Initial symptoms of choking and gagging should always indicate the possibility of foreign body and call for its exclusion.

2. Roentgen ray studies for foreign body in the alimentary canal should include the entire food passages from the nasopharynx to the terminal portion of the rectum, inclusive.

3. In cases of nonopaque foreign bodies in the esophagus the roentgenologist cannot give a definite opinion until he has used a radiopaque material, either in capsule or as a mixture.

4. To be of value in solving mechanical problems radiograms should be made in the anteroposterior and in the lateral positions (the latter at right angles to the former). In addition to these, the roentgenologist should make films which show the greatest plane of the foreign body.

5. Every patient suffering with dyspnea of unknown etiology should be examined with the roentgen ray to rule out, among other things, the presence of an esophageal foreign body.

6. Persistence of symptoms referable to the esophagus in the presence of negative roentgen ray findings calls for a diagnostic esophagoscopy.

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2. Jackson, Chevalier: Bronschoscopic Removal of Safety Pins. Arch. Otol., 3:423 (May), 1926.

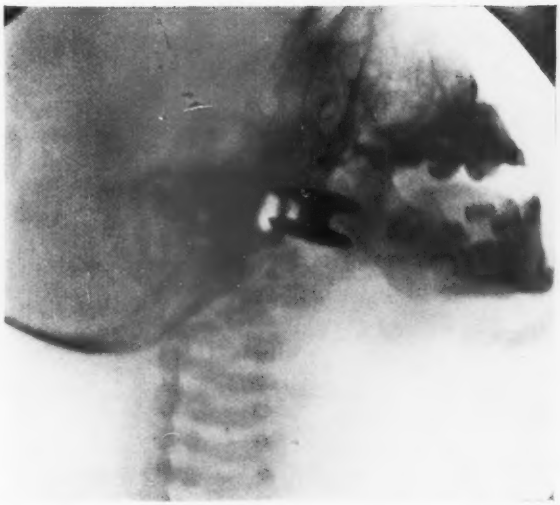

Fig. 1. Roentgenogram showing a machine bobbin in the nasopharynx of a child 16 months of age. Because of the high position of the foreign body it might readily have been overlooked had the roentgenologist included only the neck and chest in the routine examination. (Films by Dr. W. F. Manges.)

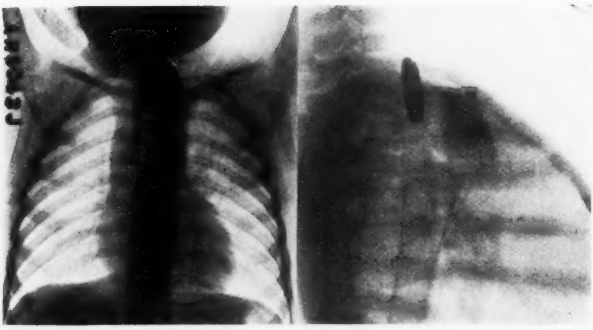

Fig. 2. Roentgenogram made in the anteroposterior and lateral positions by Dr. W. F. Manges. The former reveals a coin shaped shadow at the level of the suprasternal notch, but gives no clue to the presence of two objects, since they overlie one another. In the lateral view there is a distinct offset at the upper margin of the shadow suggesting the presence of two discs.

Fig. 3. Multiple foreign bodies, namely grape skins, string beans and part of the breast bone of a chicken removed from the esophagus of a nurse. (Actual size.)

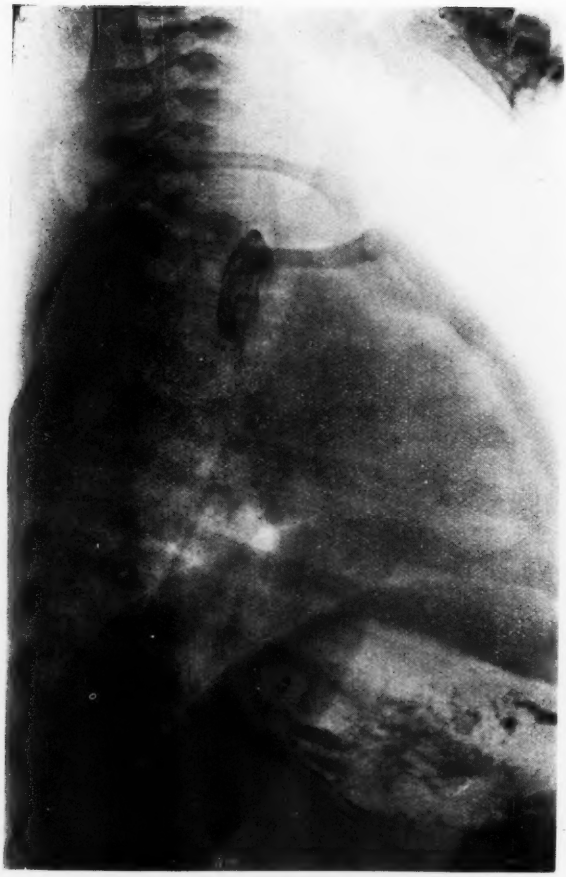

Fig. 4. Roentgenogram made by Dr. W. F. Manges reveals a foreign body in the esophagus directly behind the manubrium in a child aged one year. A part of the circumference of the button and one of the holes is outlined by the opaque mixture. Some of the mixture has reached the stomach. There is marked periesophageal swelling and the trachea is compressed as well as displaced forward. In the anteroposterior films there was observed some deviation of the trachea to the right.

Fig. 5. Roentgenogram made by Dr. W. F. Manges reveals the bismuth mixture surmounting, in caplike fashion, a nonopaque, ovoid object at the level of the suprasternal notch. No bismuth passed beyond this point, indicating that the obstruction to the esophageal lumen was complete. The foreign body proved to be a pecan nut, which was nonopaque to the roentgen ray.

Fig. 6. Pecan nut (actual size) removed from the esophagus of a man aged 32 years. The foreign body was nonopaque to the roentgen ray, its presence being demonstrated by the use of a bismuth subnitrate mixture.

Fig. 7. Roentgenogram showing a very broad artificial denture in the esophagus at the level of the suprasternal notch. Pain referred to the left of the ensiform cartilage was complained of by the patient. (Films by Dr. J. T. Farrell, Jr.)

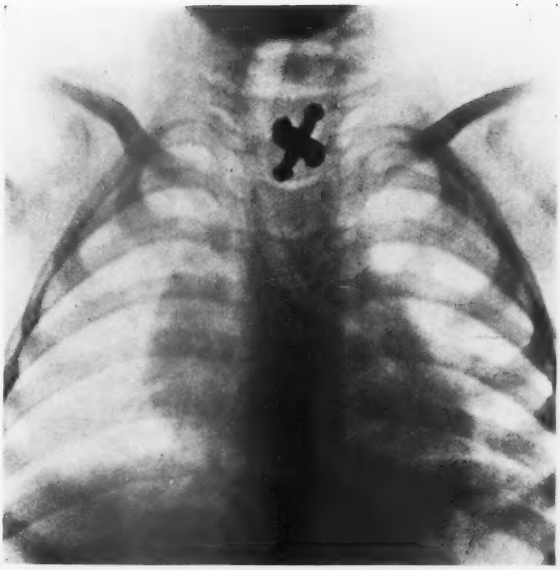

Fig. 8. Roentgenogram made by Dr. H. K. Pancoast revealed a jackstone in the esophagus at the level of the suprasternal notch. The trachea is deviated to the right and its lumen is encroached upon by the irregular foreign body.

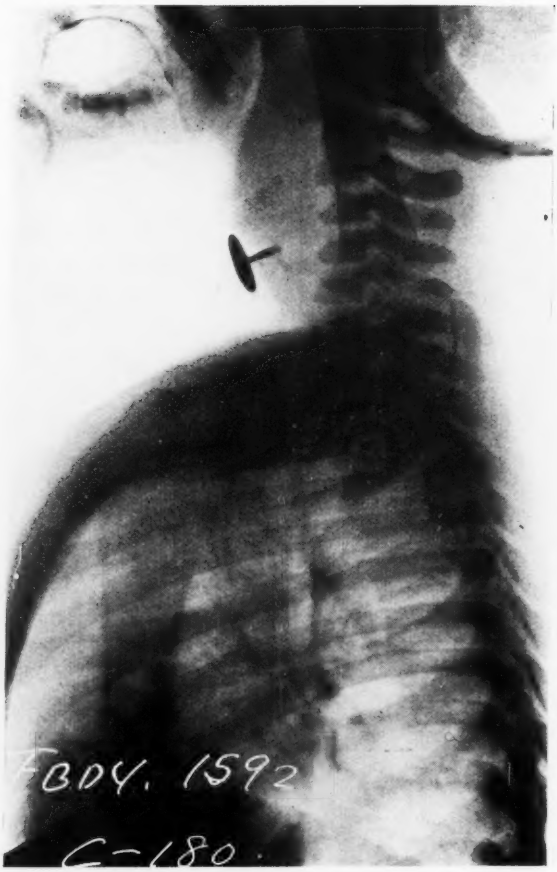

Fig. 9. Roentgenogram made in the lateral position in the case of a child, aged 19 months, shows a thumb tack in the esophagus with its point directed backward, penetrating the retroesophageal tissues. There is marked swelling and bulging forward of the retropharyngeal and retroesophageal tissues with resulting compression of the airway. A small bubble of gas or air is observed about the point of the tack. (Films by Dr. W. F. Manges.)

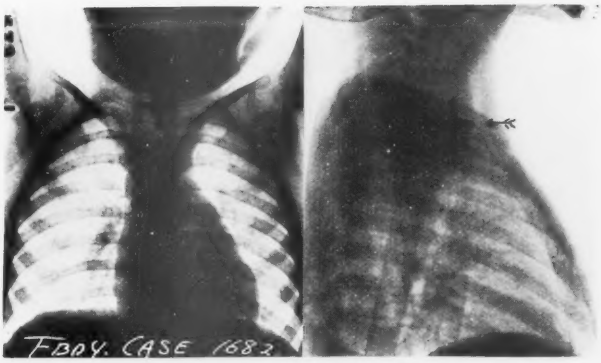

Fig. 10. Roentgenograms made by Dr. W. F. Manges in the anteroposterior position show a jackstone in the esophagus of a child at the level of the suprasternal notch. The trachea is displaced forward, being somewhat flattened. One point of the foreign body projects forward into the tracheal lumen, the point directly opposite being imbedded in the posterior esophageal wall. In the anteroposterior view the anterior extremity lies directly in the shadow of the trachea.

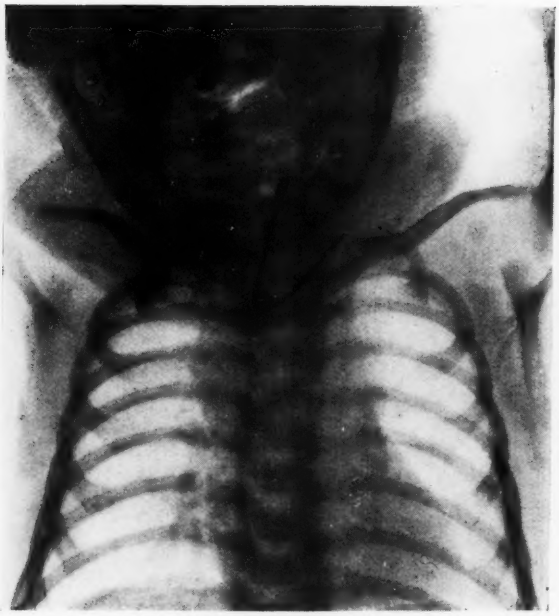

Fig. 11. Roentgenogram made in the case of a child, aged 21 days, who five days before had swallowed an open safety pin. The point is directed to the left, being above the level of the suprasternal notch, the spring being below that point. (Films by Dr. John T. Farrell, Jr.)

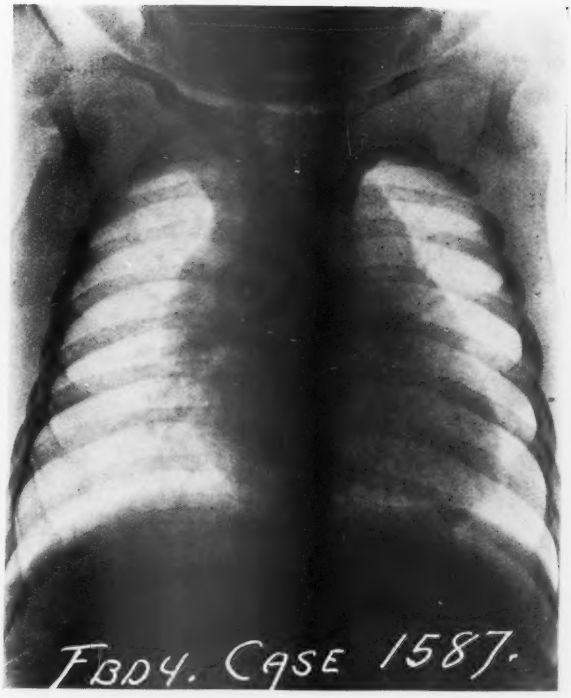

Fig. 12. Roentgenogram made by Dr. W. F. Manges shows an open safety pin, pointed extremity downward, in the thoracic esophagus of a child aged 4 months. There was also observed an unusual widening of the upper mediastinum. The pointed extremity is so far to the right that it seems to be outside of the corresponding wall of the esophagus. (The patient's temperature remained normal throughout and the subsequent progress of the patient showed nothing to indicate the presence of a mediastinitis or infective periesophagitis.)

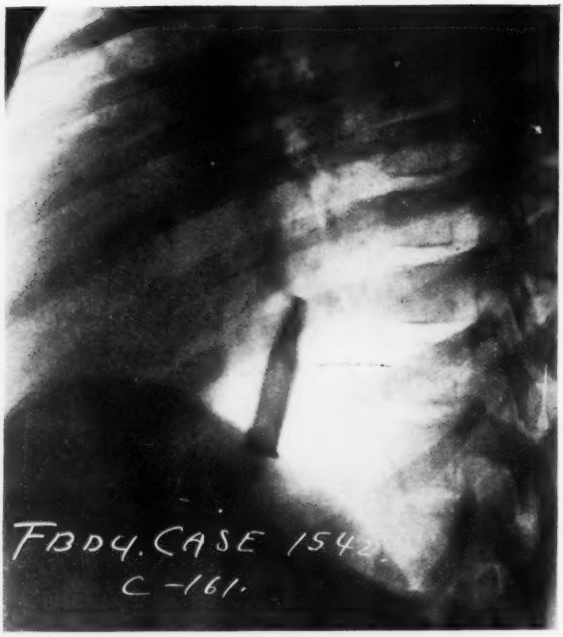

Fig. 13. Roentgenogram made in the lateral plane shows a large metallic foreign body in the esophagus just above the hiatal level, apparently resting on the diaphragm. There was nothing observed to indicate why the object remained at this level. Following its removal studies of the esophagus revealed no abnormality. In the antero-posterior radiogram the outline of the foreign body was almost completely obscured by the visceral shadows. (Films by Dr. W. F. Manges.)

LXXIV.

OBSERVATIONS ON SALIVARY SECRETION AND ASSOCIATED CLINICAL FINDINGS.

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"Canker sores" have been universally observed for generations, and yet it is doubtful if any other condition has called forth less endeavor to ascertain a definite cause. Our grandmothers, upon diagnosing a case of "sore mouth," immediately instituted a course of calomel or boneset tea, observing more or less positively that the patient had stomach trouble and was "bilious." Later, the unscientific administration of catnip tea, sulphur and molasses, flaxseed and onion poultices was ridiculed, and the old family doctor and the grandmother were belittled by the younger men, who had little time for the theory that upset gastric economy had any relationship whatsoever to the canker sore. Recently, however, we have come to realize that many of these old sayings were based on years of observation with no means to substantiate the belief.

Stomatitis is such a common condition that practically every physician has had patients come to him complaining of it, and, oddly enough, there is almost nothing in the medical literature which goes deeper into the question than to suggest treatment by cautery and an alkalin mouth wash. Recently some research has been done from a purely chemical point of view, but before taking up the chemistry of the saliva it might be well briefly to consider the embryology, anatomy and nerve supply of the salivary glands.

Anatomy (Gray).—The parotid is located in the side of the face, close to and in front of the ear, with its duct opening in the buccal cavity opposite the second molar of the upper jaw. The blood supply comes from a branch of the external carotid artery and carries in with it sympathetic nerve fibers,

while with the facial branch, the auriculotemporal and great auricular nerves go to make up a very complicated and diversified nerve mechanism.

The submaxillary gland, just below the angle of the jaw, and the sublingual, lying just beneath the mucosa of the floor of the mouth, both have their openings along the frenum. Both receive rich blood supply from the lingual artery. The nerve supply of the submaxillary gland comes from the submaxillary ganglion, together with the filaments from the chorda tympani, inferior maxillary and sympathetic nerves.

The glands secrete two types of saliva—one a thin watery fluid which issues chiefly from the parotid and the other a serum albumin which is disseminated mostly from the submaxillary and sublingual glands.

Comparative Anatomy.—In the lower animals the mouth is supplied by glands secreting a slimy fluid to moisten the surface of the mouth and alimentary tract. As a species rises in the zoologic scale we find that the glands become more specialized and important factors in digestion. The differentiation becomes quite marked in the amphibia and reptiles, but not until we reach the mammals is the acinous function found to be well defined and the parotid, submaxillary and sublingual are observed each with special and distinct types of secretion.

Embryologically, the salivary glands develop from the ectodermal layer, the parotid from the alveolobuccal fold or groove, and the submaxillary and sublingual from the alveololingual groove. The histogenetic development is not complete until after birth, usually after the child is weaned or as the demand for a more complicated diet is manifest.

Nerve Supply.—The most important detail in considering the anatomy of the salivary glands is a minute study of their innervation. The nerve mechanism of the submaxillary gland is the chorda tympani and cervical sympathetics, and stimulation of these produces a limpid, clear saliva, while stimulation of the sympathetics, which come in with the carotid, gives a thick, opaque saliva, rich in solid material. There are also filaments in the sympathetic supply which inhibit the flow of saliva. Although the vasomotor action and state of glandular

circulation are factors in the mechanism of the gland, they are in themselves incapable of controlling the secretion. There is a point in the floor of the fourth ventricle of the brain which causes abundant salivation on stimulation.

The sympathetics also form a reflex arc peripherally; hence, salivation is activated by psychic stimuli (Pawlow) and bucco-salivation is activated by taste and the movements of the tongue and cheek muscles. The act of mastication especially stimulates the parotid, and also the submaxillary through the filaments of the seventh nerve.

The other reflex arc is that of the esophageal region, which is commonly seen in tubing and bougie introduction. It is transmitted by way of the pneumogastric nerve, and promotes a viscid saliva, which moistens a bolus of food quite efficaciously.

Deglutition, nausea and regurgitation provoke salivary secretion, and the reflex action from the stomach is well known.

In brief, the sympathetics play an important rôle in the nerve mechanism of the salivary glands, as they also do in the innervation of the gastric mucosa. It is, therefore, not entirely fallacious to say that the gastric secretion and salivary secretion are intimately connected. Logical as this may appear, as yet we have no definite findings or laboratory data to confirm our belief.

Most of us have accepted the dictum that acid saliva is an etiologic factor in "cankrum oris," and, acting upon this, we have given alkalin mouth washes and sprays and gargles. In an endeavor to check up on the efficacy of this procedure, we began to investigate saliva by chemical analysis and determination of the hydrogen ion concentration.

Human saliva loses carbon dioxid very rapidly, and thus alters the reaction for any investigation if air is allowed to mix with it. In view of this, it is necessary to collect the saliva under oil and then proceed with the analysis. Also it has been proven that the chewing of paraffin to stimulate salivary flow leads to error. We place a glass tube of fairly large caliber in the mouth and carry the distal end through a film of mineral oil. The patient is allowed to sit quietly, and as the saliva

gathers and runs down the tube the oil floats on the surface and thus excludes the action of the air (Fig. 1). This gives about as near a normal flow and as accurate results as any method, both for quantity and content. The colorimetric method of determining hydrogen ion concentration, as outlined by Starr, was used.

The results of our efforts showed that, contrary to the popular belief and general assertions of dental publications, the acidity of the saliva is not definitely altered in cases of stomatitis or cankrum oris, as shown by the hydrogen ion concentration. We found the hydrogen ion concentration in our cases to average 6.60. This finding coincides with results reported by Starr, who found the average for mixed saliva in 610 specimens to be 6.6. In very few cases we found a tendency for decreased hydrogen ion concentration, which would indicate an increase in acidity. In other words, the acidity, as determined by the hydrogen ion concentration, is a constant and unchanging factor.

Analysis of saliva has been shown to yield per 1000 grams:

Water, 995.16.
Epithelial tissue, 1.62.
Soluble organic, 1.34.
Potassium sulphocyanide, 1.06.
Inorganic salts, 1.82.

The excess of ammonium salts will cause an increasingly rapid breakdown or decomposition in the presence of air, and sulphocyanides will produce an added fetid odor or halitosis. It is absurd to advise removal of tonsils or the use of gargles and chemical dentifrices to cure halitosis of this type, as it is due to a peculiar balance of the chemicals already in the saliva. The best treatment in such cases consists in the administration of some substance, such as iodids, which will be resecreted in the saliva. The disadvantage of treatment with iodids is that we cannot keep the patient on them indefinitely. It has been observed that upon the administration of neoarsphenamin patients have complained of smelling ether and for a few days noticed a metallic taste. We have administered neoarsphenamin intravenously as a regular course, with a noticeable improvement in the salivary odor. There is also a

general systemic improvement, due to the tonic effect of the arsenic, which may be the real basis for improvement. We have not employed this therapy over a sufficient length of time to warrant a statement regarding the permanency of the improvement.

The socalled "acid mouth," associated with stomatitis and cankrum oris, has been of considerable interest. In conjunction with the hydrogen ion concentration of the saliva, we studied the acidity of the gastric secretion, and, much to our surprise, found a tendency to stomatitis in young adults whose secretions were bordering on a low acid scale. They were at the lower limits of normal but not true hypochlorhydria. It seems not unreasonable to state that the sore mouth may have its causative factor in a relatively high acid content of the saliva, as compared to the decreased acidity of the gastric secretion. These patients were given hydrochloric acid (diluted), 10 drops to a dram, three times daily, in water, with gratifying results.

One of the most typical cases is that of Miss L., a student, aged 22, who had had canker sores and stomatitis for two years, at times so severe that eating was impossible. The sores had been cauterized and treated with alkalin mouth washes, and the most severe lesions had even been subjected to treatment with radium. Upon examination, we found the margin of the tongue covered with lesions, and noted a number of sores on the buccal mucosa. The tonsils had been removed, and other examinations were negative. The hydrogen ion concentration of the saliva was 6.6, and the gastric hydrochloric acid was 32, against 40 as normal. Dilute hydrochloric acid, 10 drops in water after meals, was prescribed without other medication. The patient reported one month later, and the mouth was free from lesions for the first time in two years. Some of the old lesions were marked by scars and atrophy. Later she voluntarily discontinued the hydrochloric acid, and in three weeks the lesions began to develop. On resuming the acid medication the lesions again disappeared. The patient has put on weight, has returned to her school work, and in every way is much better. When I last saw her she was in excellent condition. The hydrogen ion concentration of the

saliva was unchanged, 6.6, and the results of the gastric analysis were about the same. This young woman finds that hydrochloric acid is necessary in her gastric economy.

In older individuals the canker sores are absent, but there is a burning of the tongue and some pharyngeal soreness, with difficulty in swallowing. Many of these patients have spent a good deal of money and considerable time experimenting with local mouth washes, and so forth, some have had tonsillectomies, and others have had dental extractions with no improvement. Some have developed a marked phobia relative to cancer, the burning of the tongue being a predominate symptom. There is a definite decrease in the quantity, even to the point of aptyalia.

Examination reveals a shiny tongue. The first factor of importance is the dry mucosa, and on wiping the cheek and under the tongue we notice the saliva is secreted very slowly; in fact, the mucosa becomes glazed. This explains the difficulty in swallowing; there is not sufficient saliva to properly moisten the bolus of food.

Examination of the saliva shows a hydrogen ion concentration ranging from 6.5 to 6.7, and gastric analysis shows an achlorhydria or achylia gastrica. These findings are characteristic and sufficient indication for the administration of hydrochloric acid. These patients improve in general well being, but the salivary secretion is not materially benefited, due, no doubt, to the fact that there may have been an atrophy of the acini in the glands themselves.

I do not believe that the lowered gastric acidity is a cause for the salivary change. It is more than likely that the disturbance lies in an imbalance of the nervous mechanism, and that the same causative factor affects both, inasmuch as the sympathetic system plays such an important rôle in regulating both the salivary and gastric glands. Just what the nature of the neurologic disturbance may be, it is impossible to say. Many of these patients are of the socalled neurotic type, and there may be some neurologic basis. The administration of hydrochloric acid does not stimulate the glands materially any more than it increases the secretion of hydrochloric acid in the stomach. It is necessary to the digestive economy but does

not activate the glands. It may have to be given throughout a long period of time.

There are other conditions which cause a decrease in the quantity of salivary secretion. In chronic tuberculosis we find a scanty saliva. In grave cardiac cases we find diminished secretion of saliva, and this is also true in cardiorenal cases and myxedema. Also, in many cases the condition may be a forerunnner of pernicious anemia, and the same clinical picture has been observed associated with abdominal malignancies.

This paper has been prepared, not with the idea of making astonishing assertions or startling discoveries. I became interested, from the laryngologist's viewpoint, because these patients eventually are referred to the laryngologist, either for the treatment of the stomatitis or for the removal of tonsils to relieve the burning and sore mouth. As operation does not afford relief, they are always dissatisfied, and the otolaryngologist is placed in an embarrassing situation. The treatment, as outlined above, should not necessarily be carried out by the nose and throat specialist, but we should recognize the condition as consultants, and give our advice accordingly. The patient should be warned that tonsillectomy, dental extractions, mouth washes, and so forth, will not cure or relieve the condition. I believe that cases of stomatitis fall in that classification of borderline cases wherein the cooperation of the laryngologist is essential.

It is hoped that someone who has access to every laboratory facility will become interested in this subject, and that further investigation will bring to light additional findings fundamental to a proper understanding of these cases. The literature on stomatitis is woefully scanty and inadequate, and yet the type of case herein described is common in everyone's practice.

CONCLUSIONS.

1. Cankrum oris is not a disease entity but an oral manifestation of some general disturbance.

2. Cankrum oris in young adults should warrant careful investigation, with special reference to gastric acidity.

3. Stomatitis, glossitis, or aptyalia in individuals more than 40 years of age should call for investigation of the gastric

acidity and warn of the possibility of intestinal malignancy or pernicious anemia.

4. Alkalin mouth washes in the majority of these cases is of little value, and satisfactory results have been obtained by the administration of dilute hydrochloric acid.

5. Glossitis, stomatitis and cankrum oris are lesions on which the otolaryngologist may be called upon to pass judgment. Tonsillectomy and further surgical procedures should be postponed until other factors are ruled out.

6. The acidity of the saliva is apparently a constant factor and is not markedly affected by disease.

Fig. 1. Method of collecting saliva under a film of oil.

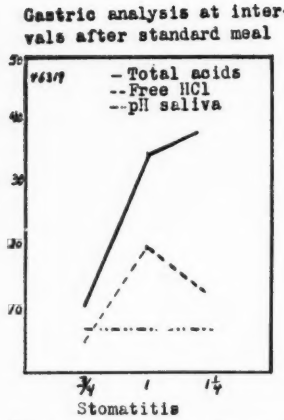

Fig. 2. Patient aged 26 years. Severe stomatitis and cankrum oris; marked decrease in free HCl. Symptoms relieved on administration of HCl.

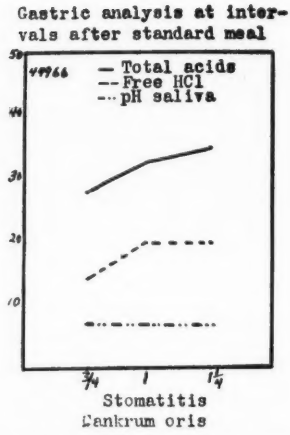

Fig. 3. Patient aged 17 years. Marked stomatitis and canker sores; moderate decrease in free HCl. Symptoms disappeared on administration of HCl.

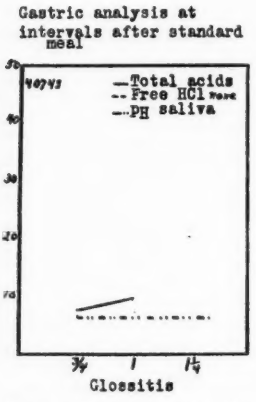

Fig. 4. Patient aged 25 years. Marked tingling of the tongue; free HCl, 0 and marked decrease in total acids. Administration of HCl relieved the glossitis.

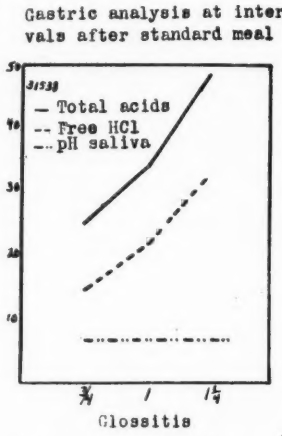

Fig. 5. Patient aged 24 years. Marked tingling and burning of the tongue; moderate decrease in free HCl. Symptoms disappeared on HCl.

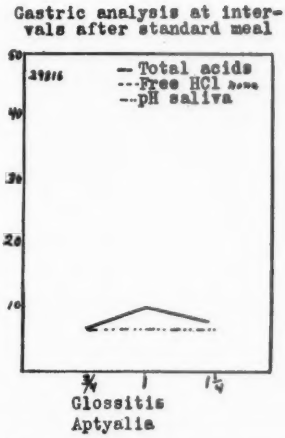

Fig. 6. Patient aged 59 years. Marked glossitis and difficulty in swallowing; aptyalia; free HCl, 0, and total acids 10. Glossitis relieved with HCl; amount of salivary secretion not affected.

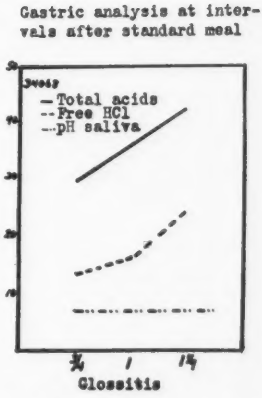

Fig. 7. Patient aged 19 years. Recurrent attacks of cankrum oris for three years; total acids and free HCl decreased to lower limits of normal. Symptoms relieved with HCl.

Fig. 8. Results of gastric analysis in cases of glossitis, and stomatitis and cankrum oris.

	pH	Total Acids			Free HCl		
Case	Saliva	¾ hr.	1 hr.	1¼ hr.	¾ hr.	1 hr.	1¼ hr.
40743	6.6	8	10	....	0	0	0
34068	6.6	30	36	42	14	17	24
44966	6.6	28	33	35	14	20	20
46319	6.6	11	35	38	4..5	20	13
29816	6.6	7	10	8	0	0	0
31538	6.6	25	34	48	15	22	32

The average normal reading of HCl is 40.
The average normal total acidity is 60.

LXXV.

THE SACCUS ENDOLYMPHATICUS AND ITS RELATION TO LABYRINTHINE MUSCLE TONUS.

By Hector G. La Reau, B. S., M. D.,

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Despite the very many investigations and publications on the subject, there is still a host of unsettled questions in regard to the physiology of the labyrinth. The gross anatomy of this complicated structure is well known, but the physiology, both as regards the whole apparatus and its various components, is not clear. Whether in the living organisms the fluids, traversing the various structures, obey hydrodynamic laws is not satisfactorily known, inasmuch as investigations have generally been made on isolated labyrinths and not in the living.

Any contribution, therefore, however slight, to the physiology of the labyrinth may have its value in elucidating the functions of the organ; and it is with this idea that I publish the results of some studies which I have made in regard to the function of the saccus endolymphaticus.

ANATOMY.

As far back as the eighteenth century Cotugno[1] had established that the labyrinth was not a closed space but that it communicated with the space behind the lamellæ of the dura by means of the aqueduct of the vestibule. This fact was definitely established in 1879 by Weber Liel,[2] who showed that the endolymph space was in direct communication by a ductus with the saccus endolymphaticus and that the perilymphatic space communicated with the subarachnoid space by the aqueduct of the cochlea. Weber Liel was of the opinion, therefore, that cerebrospinal fluid tension could, with the perilymph as an intermediary, be transmitted to the saccus endolymphaticus and thus affect the labyrinth. Grünberg[3] has quite recently

taken up the question of demonstration of the existence of an open ductus perilymphaticus, but I do not wish to enter into the discussion of this.

It will be well now to consider shortly the relations between the labyrinthine organs, the utriculus sacculus and ductus endolymphaticus. The earlier views, as expressed by Cannieu[4] and Vialleton,[5] were that the ductus endolymphaticus in the embryo originated from the deep face of the epithelial wall of the otocyst under the form of a hollow bud, the extremity of which later became the saccus endolymphaticus. Hertwig[6] considered that the endolymph canal and the ductus endolymphaticus bifurcated at its origin into two branches, one communicating with the saccule and the other with the utricle. All writers agree that the saccule and utricle are only in relation of continuity by the ductus endolymphaticus; but Portmann,[7] who has thoroughly studied the saccus endolymphaticus in fishes, mammals and man, has shown that the method of communication is different from that described by Hertwig. This investigator shows that the saccus insensibly narrows into the ductus, and at about one-third of its course widens out again into the sacculus, and it is from this that communication is made with the utricle and cochlear canal by the intermediary of two small canaliculi. There is no direct communication of these structures with the ductus.

These dispositions are shown on the accompanying plate reproduced from Portmann's article.

The endolymph apparatus may be considered as a bilobated structure, one extremity, the saccus endolymphaticus, being intracranial, and the other extremity, the sacculus, being the vestibular expansion.

The saccus endolymphaticus is embedded in the endolymphatic fossa which, as described by Portmann,[7] is situated at the level of the external third of the posterior face of the petrous bone.

This fossa, as Portmann remarks, is quite roomy enough to accommodate variations in the volume of the saccus.

The sacculus and saccus endolymphaticus with the duct form an organ which is independent of but in communication with the organ of equilibrium (utricle) and the organ of audition (cochlea).

PHYSIOLOGIC FUNCTIONS OF THE DUCTUS ENDOLYMPHATICUS.

Before dealing with the physiologic functions proper of the ductus endolymphaticus, it will be necessary to briefly refer to the functions of the labyrinthine apparatus in general, in so far as they relate to equilibrium and orientation. Breuer,[8] in 1875, showed that in general there were two types of labyrinthine reflexes, one corresponding to movements which he referred to the semicircular canals, the other corresponding to position and referred to the otoliths. The nervous end organs—the cristæ and cupulæ—of the semicircular canals moved freely in the endolymph of the canals and were adapted to respond to movements of the head; the maculæ, covered by the otolithic membranes, were specifically adapted to changes in the pressure of these membranes produced by alterations of the head in space.

It has been assumed down to the present time that the adequate stimuli of the end organs of the semicircular canals were endolymph currents within the canals. Ewald,[9] whose views have generally been accepted, asserted that ampullofugal movement of the endolymph in the canals diminished the rest tonus of the labyrinth and that ampullopetal movement increased the rest tonus. Rejto[10] has, however, recently shown by investigation that this dictum of Ewald should be reversed. According to Rejto, an ampullopetal endolymph current produces (in the horizontal as well as in the posterior canal) always a movement of the head toward the right and an ampullofugal current in both canals produces movement toward the same side.

It is more than forty years since Hogyes[11] first demonstrated experimentally that the labyrinthine tonus does not diffuse to every muscle on the same side of the body, but that it goes partly to the muscle groups on the same side and partly to muscle groups on the other side, according to their agonist or antagonist functions. There has not been much change in our conception of labyrinthine muscle tonus distribution since Hogyes' time, but it is not necessary to enter into the question of this distribution, but rather with the excitation of tonus.

De Klejn[12] has shown very clearly that the muscle tonus labyrinthine reflexes are otolith reflexes alone. Maxwell's[13] [14] work on fishes had led him to the same conclusion, that the approximation of the surfaces of the otolith and macula suggested a mechanical arrangement by which any alteration of the position of the head would cause a corresponding change of pressure, and that such a pressure or tension change could act as a stimulus to excite the appropriate compensatory movements. Maxwell places no importance in endolymph currents within the canals as a nerve excitant, though he thinks such movements may be a means of equalizing pressure. Quix[15] holds a similar view, but extends it by including perilymphatic pressure through the saccus. Quix thinks that increase of pressure of the otolith on the macula increases the tonus of the flexors of neck, trunk, etc., and diminishes tonus of antagonistic muscle groups. Diminution of pressure has the contrary effect. Maxwell's views differ from De Klejn's inasmuch as while the latter thinks that muscle tonus reflexes are purely otolithic, the former thinks that no sharp differentiation can be drawn and that both otoliths and semicircular canals reinforce each other. However, when the otoliths and utricle are removed from fishes static and dynamic functions of equilibrium are completely lost.

It should be noted that in fishes the endolymph saccus is an open and not a closed organ as in man.

Shambaugh,[16] while admitting that the macula acoustica may take a part in supplying labyrinthine tonus, yet thinks that the crista ampullaris, the end organ of the semicircular canals, plays the most important rôle in tonus. Shambaugh believes that the nerve stimulus arises from movements of the endolymph but that this is a to and fro movement excited in the fluid by the pulsations of the labyrinth artery.

We have then several theories in regard to the excitation of labyrinthine tonus: Breuer's assumption of endolymph currents; Ewald's assumption that the hair cells of the crista were in a state of ciliary motion which constituted a constant stimulus of the hair cells; the theory of otolith pressure on the macula and relative tension differences, as propounded by Maxwell and others; and Shambaugh's theory of vascular pulsations transmitted to the endolymph. All authors agree that

there must be a constant stimulation of the nerve endings in order to account for labyrinthine muscle tonus, and hence Shambaugh's vascular theory appeals to me to be the most logical, as it is based on a constantly present physiologic factor —i. e., arterial pulsation. Recent experimental investigations by Wodak and Fisher,[17] from which these authors deduce that tonus vestibular reactions are independent of a vascular reaction, do not appear to me to invalidate Shambaugh's hypothesis. Their artificial vasoconstrictors and vasodilators, besides their action on the endolymph, have also a certain nervous action.

That endolymph currents exist does not appear to have been seriously denied, although the stimulatory effects of such currents have been debated. One important point, however, appears to have been overlooked by all investigators, and this is that it is physically impossible for a fluid to move in a closed tube. Such movements can only take place in a tube when the ends are open and free.

The endolymph apparatus or membranous labyrinth in man may for practical purposes be regarded as a tube with expansions at each end which allow motion of the fluid contents in either direction. As has been shown, the two expansions are the sacculus and the saccus endolymphaticus. The sacculus may, however, be broadly considered as a necessary and integral part of the labyrinthine apparatus, while the saccus does not seem to be so, unless for the one function of permitting movement of fluid in the labyrinthine organs. This, then, is what I consider one necessary function of the saccus endolymphaticus—i. e., that as an expansation chamber it permits motion of fluids in the semicircular canals and other parts of the labyrinth; were the saccus not there the labyrinth could be considered as a closed system and movement of the fluid within it would not be possible. The constant to and fro movements of the endolymph in the canals, due to vascular pulsations transmitted to it, keep the cristæ constantly moving and thus supply the necessary stimulus for labyrinthine tonus.

In the absence of such stimuli there could be no labyrinthine muscle tonus. The saccus endolymphaticus is, therefore, absolutely necessary for functional labyrinthine muscle tonus.

The accompanying schematic drawing and explanation of the simple experiments performed with an apparatus which it represents illustrate the physical law which shows the necessity for an expansion sac like the saccus endolymphaticus in the scheme of the labyrinth.

I have already referred to another function of the saccus endolymphaticus—i. e., that it receives through the perilymph expression of cerebrospinal tensions and transmits such pressure to the labyrinth.

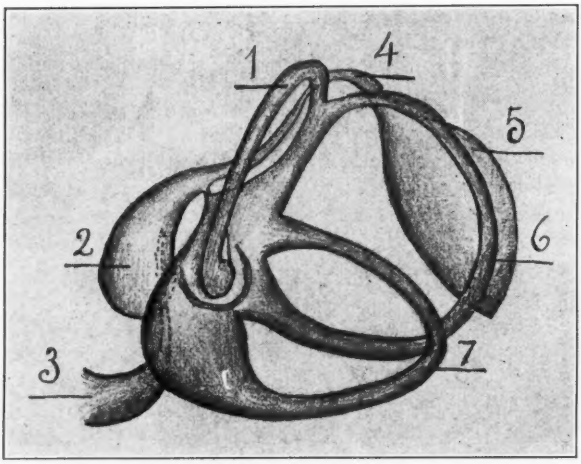

FIGURE 1.

1—Superior semicircular canal.
2—Sacculus
3—Cochlear canal.
4—Endolymphatic canal.
5—Saccus endolymphaticus.
6—Posterior semicircular canal.
7—External semicircular canal.

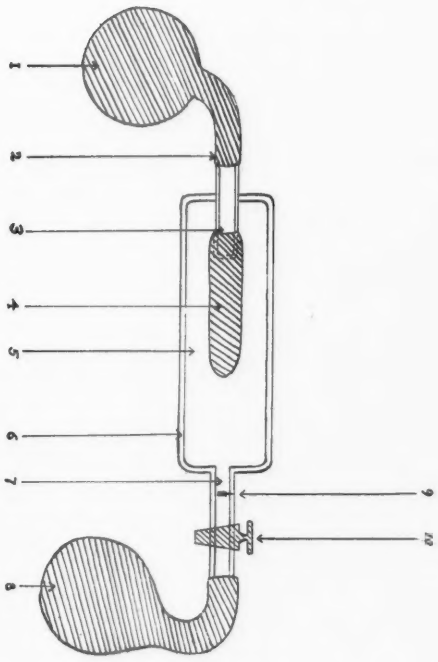

FIGURE 2.

The diagram represents a system of tubes filled with water. 1 is a compressible rubber bulb, the diagrammatic equivalent of the source of the vascular pulsation, namely, the heart; 2, 3, 4, the vascular system of the labyrinth. No. 4 is a flexible rubber finger cot. No. 5, 6 and 7, glass container, the diagrammatic equivalent of the labyrinth and its endolymph content. No. 9, a small metal indicator, suspended free in the fluid, crista ampullaris. No. 10 is a glass stopcock. No. 8 is a flexible rubber bag and tube corresponding to the saccus endolymphaticus.

Small compressions of the bag No. 1 are communicated to the fluid No. 5 through No. 4 and set in motion indicator No. 9, when the stopcock is open and the bag No. 8 (saccus endolymphaticus) permits the pulsations. When the stopcock is closed, compressions of bag No. 1 have no effect upon the indicator No. 9. Illustrating the effect produced by Portmann is blocking off the ductus endolymphaticus.

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LXXVI.

THE DIAGNOSIS AND TREATMENT OF LARYNGEAL TUBERCULOSIS.*

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There seems to be a general impression that laryngeal tuberculosis is a fatal complication of pulmonary tuberculosis for which little can be done in the way of treatment or cure.

Such an opinion is entirely erroneous, for no condition responds more rapidly to properly directed treatment than tuberculous laryngitis if a diagnosis is made reasonably early.

For this reason it is most important that every effort be made to discover a lesion as soon as possible after development. As a matter of fact, every patient afflicted with pulmonary tuberculosis should be considered a possible case which is likely to develop laryngeal complications, as records show that approximately one-third of all patients have laryngeal infection, and necropsy reports reveal that in more than 50 per cent of fatal cases laryngeal lesions can be demonstrated.

Next to intestinal complications, the larynx is most frequently invaded in tuberculosis. The symptoms produced here have a marked influence on the progress of the general disease, for no patient can recover if he has excruciating pain and regurgitation of food through his nose every time he attempts to swallow. Any ulcerating surface in this region is irritable, and cough is usually an aggravating symptom which disturbs the patient's sleep and peace of mind so that he cannot get the amount of rest so necessary for the cure of tuberculosis.

When we consider that tuberculosis is our most prevalent disease, it is evident that this subject should be of interest to everyone.

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*Read before the American Laryngological, Rhinological and Otological Society, at Montreal, June 2, 1926.

DIAGNOSIS.

The diagnosis of tuberculous laryngitis is not difficult, although frequently neglected until serious pathologic changes have occurred. Too much cannot be said about the importance of early diagnosis in these cases, for intrinsic lesions respond readily to treatment, and most cases can be effectively cured.

It is a mistake to wait for the usual classical subjective symptoms to develop, such as huskiness of the voice, hoarseness, pain referred to the ear or throat, and dysphagia, before examining the larynx. Many cases will show a well developed lesion before subjective symptoms appear. For this reason every patient with pulmonary tuberculosis should be considered a potential case for the development of laryngeal complications. When pulmonary tuberculosis is recognized, it is the duty of the clinician to see that a careful laryngeal examination is made. Even though the throat appears normal on first examination, regular routine laryngoscopies should be made to look for suspicious areas.

Every sanatorium for the treatment of tuberculosis should have not only a skilled laryngologist on its staff, but all physicians in the institution should be instructed to make a satisfactory laryngeal examination.

If more attention is given to this subject, unquestionably the frequency of severe complications can be lessened and many fatal cases prevented.

When examining a throat for early tuberculous involvement very careful investigation of the posterior laryngeal wall should be made, for in most cases this is the most frequent as well as the first area to be infected.

The anatomic construction of the interarytenoid region makes it particularly susceptible to the invasion of tubercle bacilli. Supported by a loose connective tissue framework, the mucous membrane is thrown into folds by active movement during phonation, respiration, coughing and deglutition. So that infected sputum, which is being continually coughed up, passes over this irregular surface, and much of it remains in constant contact with the deeper crypts, especially when the patient is lying down.

After a time the irritating and devitalizing action of toxins produces a reaction and erosion of this mucosa. There may be at first only a single hyperemia or the tissue may be infiltrated, velvety or roughened. As the process advances, gradually a hyperplasia occurs, which may be elevated and smooth or nodulated with irregular vegetations as tubercles coalesce. When the epithelium breaks down a raw ulcerating surface forms which becomes infected with mixed organisms.

The next structures in order of frequency to be involved are the vocal processes. Then the vocal cords.

The nature of the true cords makes them susceptible to attack. Cartilaginous bands covered with a thin layer of epithelial cells do not withstand the onslaughts of toxins for any great length of time without becoming damaged. Hyperemia, thickening or fusiform enlargement of one or both cords may be first noticed. Later when ulceration occurs there is irregularity, which may assume the typical mouse bitten appearance, or progress until there is much destruction of tissue and deformity, which can never be repaired.

The ventricular bands are not involved as frequently as the cords, but a lesion here may be very extensive, and tuberculoma in this region are not uncommon.

As long as tuberculosis is confined to the interarytenoid space, vocal processes, cords or ventricular bands, the lesion may be considered intrinsic, as has been suggested by St. Clair Thompson.[1] The prognosis here is much better than in affections of the arytenoids, epiglottis or pharynx.

Early involvement of the arytenoids may appear as a hyperemia or pseudoedema on one or both sides. In advancing stages, when ulceration develops, there is interference with swallowing, and dysphagia is associated with the taking of food. Nodular swellings, edema or turban shaped character and ulcerated areas are frequently seen on the epiglottis late in the disease. Involvement here is a distressing complication, as there is so much pain when taking food.

Pharyngeal tuberculosis is fortunately comparatively rare, as it is a grave condition, for which very little can be done.

An idea of the frequency of various areas affected may be obtained from a study of Lockhart's compilation[2] of 3,994

cases. The posterior wall was involved in 1,081; vocal cords, 997; arytenoid cartilages, 940; ventricular bands, 485; epiglottis, 436; subglottic space, 55.

It is the object of this paper to emphasize the importance of making a diagnosis by objective examination in an effort to recognize early lesions before they have advanced to the stage where subjective symptoms are produced. However, certain complaints of the patient are often helpful in a final diagnosis.

Dryness and burning of the throat should be regarded with suspicion in tuberculous patients, as this frequently occurs two or three weeks before a definite lesion can be made out.

Pain referred to the ear and in the region of the throat usually indicates some laryngeal infiltration, and such cases should be carefully watched. The location of the lesion has much to do with the symptoms produced, for a well advanced infection in the interarytenoid space or ventricle may give little or no disturbance, while a small degree of cord infiltration will produce huskiness of the voice and later hoarseness or aphonia.

Infiltration and ulceration around the arytenoids and epiglottis interfere with swallowing, and dysphagia is usually associated. Cough is present in most cases and becomes greatly aggravated when raw surfaces are exposed to the continual irritation of mucus and sputum.

As laryngeal involvement is practically always secondary to a pulmonary condition, we usually have associated the general symptoms of tuberculosis, such as loss of weight, night sweats, coughs, digestive disturbances, characteristic temperature, etc.

TREATMENT.

The treatment of laryngeal tuberculosis may be considered under three divisions, viz., (1) vocal rest, (2) the local lesion, (3) general treatment.

Vocal Rest.—In all cases where tuberculous invasion of the larynx has been discovered, absolute rest of the voice should be instituted. It does little good merely to tell a patient not to talk, but he should be instructed to write everything. This impresses him with the seriousness of his condition and is also very important as a curative measure. Unquestionably many

cases have been cured by silence alone, as has been frequently pointed out. So that whatever other form of treatment may be supplemented, vocal rest should be carried out religiously.

Local Lesion.—For active treatment of the local lesion, we have found the judicious use of the electric cautery most beneficial and now employ it in preference to all other methods of treatment. Our results have been most gratifying, and it is surprising that this form of treatment, which has been used by a limited number for such a long time, is not more generally employed by all laryngologists.

The technic of cauterization is simple, results are sure and complications are negligible. Cauterization can be easily carried out in an office or at the bedside without inconvenience to the patient. Local anesthesia is employed, and the indirect method is advisable; however, the direct method may be used when desired.

Experiments conducted by Wood in 1910,[1] clearly demonstrated that cauterization produced an inflammatory reaction of the tissue, with the development of new blood vessels, congestion and fibroblasts in the avascular tubercle, giving it necessary nutrition and resistance.

Following his principles and plan of treatment, we have found the use of the cautery most satisfactory, as early lesions clear up after two or three treatments, and advanced cases will show marked improvement after a few cauterizations.

Even in severe and hopeless cases the cautery is of great value as a palliative measure to relieve pain and coughing.

Only in exceptional cases do we find it necessary to inject the superior laryngeal nerve, and the use of cocain to allay pain is seldom required, since using the cauterization treatment.

General Treatment.—Whenever possible, these patients should be treated in a sanatorium, as a carefully regulated plan of general treatment of the pulmonary lesion is most necessary. It is unwise to have patients with active tuberculosis travel long distances to physicians' offices and wait in hot, crowded rooms for treatment. Under such conditions, coughing is increased and the strain of travel lowers the patient's general resistance. All of these unfavorable features are eliminated in sanatorium treatment, and the cases can be carefully fol-

lowed by both the clinician and the laryngologist, between whom there should be the closest cooperation.

At our State Sanatorium, under the direction of Dr. Victor Cullen, all cases on entrance are given a thorough physical examination, complete history, pulse and temperature record, also X-ray of chest. If the temperature is over 99.4, the patient is put to bed and kept on vocal rest for a while. As soon as the resistance is built up somewhat and the temperature begins to come down, cauterizations are started and are continued at monthly intervals until cured.

SUMMARY.

1. Every patient with pulmonary tuberculosis should be considered a possible case for the development of laryngeal complications.
2. Regular, routine laryngeal examinations should be made in all cases, as it is most important to make a diagnosis early.
3. The diagnosis should be made by objective examination, as it is a mistake to wait for subjective symptoms to develop before giving attention to the larynx.
4. If a diagnosis is made early the case can be easily cured. If delayed the prognosis is serious.
5. Treatment of the local lesion with the electric cautery has given us excellent results. We now use it in preference to all other methods of treatment.
6. The prognosis of laryngeal tuberculosis is encouraging, and cures are to be expected, if recognized early and active cauterization is employed.

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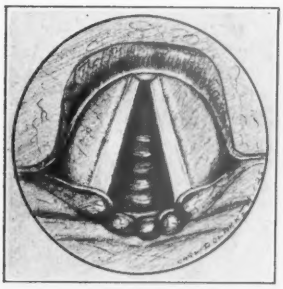


Fig. 1.
Laryngeal tuberculosis, early lesion, hyperemia and roughening of posterior laryngeal wall.

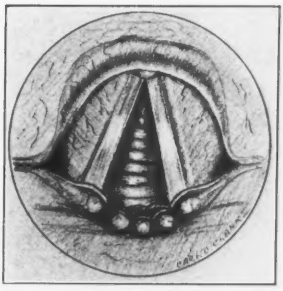


Fig. 2.
Infiltration of posterior laryngeal wall. Early tuberculous invasion.

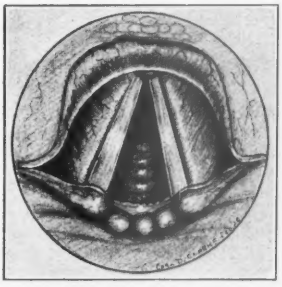


Fig. 3.
Ulceration, and irregular elevation, interarytenoid region Early tuberculosis.

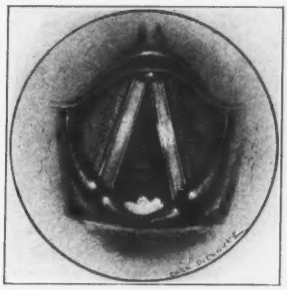


Fig. 4.
Mass with vegetation-like surface. Interarytenoid space.

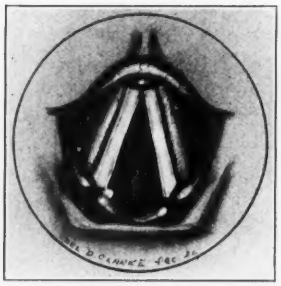


Fig. 5.
Early tubercle, vocal process.

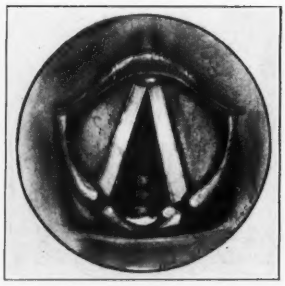


Fig. 6.
Tubercle, vocal process, infiltration, interarytenoid space.

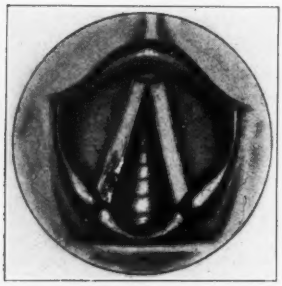


Fig. 7.
Tubercle of cord, early lesion.

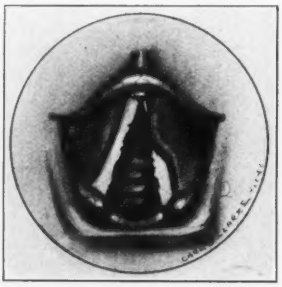


Fig. 8.
Ulceration of cords, infiltration, left ventricle.

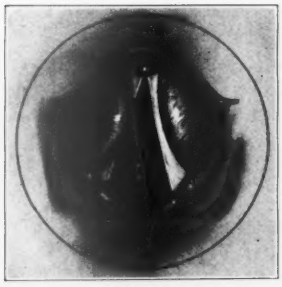


Fig. 9.
Tuberculous infiltration, ventricles.

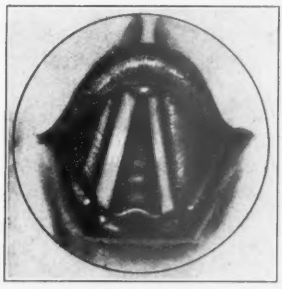
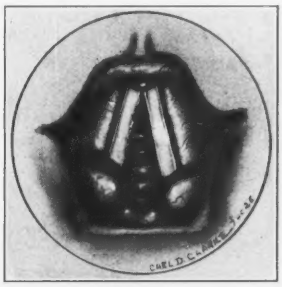


Fig. 10.
Infiltration, interarytenoid space.



No. 11.
Edema of arytenoids and ulceration of cord.

Fig. 12.
Turban shaped edema of epiglottis.

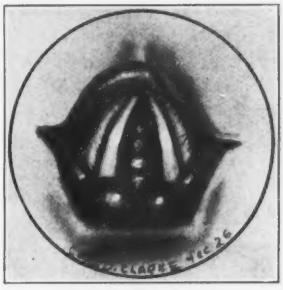


Fig 13.
Ulceration of epiglottis, edema of arytenoids.

LXXVII.

ON THE INTERPRETATION OF SPEECH SOUNDS BY MEANS OF THEIR TACTUAL CORRELATES.*

By Robert H. Gault, Ph. D.,

Professor of Psychology in Northwestern University, on leave with the National Research Council,

Washington.

I am very grateful for the opportunity to tell the members of this society something of the experimental work that has been fully engrossing my attention during the last two years with the National Research Council and that intermittently claimed my time during two earlier years. My article that was published in the Archives of Oto-Laryngology, Volume III, February, 1926, summarized the results of my work to October 16, 1925. The data in that article I shall refer to only casually. Many of you have read it entirely.

These experiments are not aimed at enabling the deaf to hear. Subjects have been selected whose deafness is of such a nature and degree that they cannot hear speech by the assistance even of any known device for the aid of the hard of hearing. By various control experiments, elsewhere described, we have satisfied ourselves that they do not obtain even auditory cues in the conditions of our experiment.

For those of you who have not read the article in the Archives, let me say that our apparatus consists of a very high quality telephonic transmitter, nine receivers in series, each of which has resistance of 58 ohms, and a three tube amplifier. The whole apparatus requires a six volt A battery, a 110 volt B battery and three dry cells. The cap of each receiver has been cut out, so that a finger or thumb has easy access to the diaphragm.

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*Read before the Chicago Laryngological and Otological Society, April 5, 1926.

Nine subjects can simultaneously receive the vibrations of the speaker's voice when their finger or thumb is resting lightly against the diaphragm of the receiver. Additional cases can be accommodated by the simple expedient of increasing the number of receivers.

Two things had been demonstrated by means of this apparatus before the article in the Archives had been written.

1. That it is possible to distinguish spoken sentences, words and the elements of which they are composed, by their tactual correlates alone and to associate meanings with tactual complexes.

The process of receiving and interpreting these tactual correlates I tentatively designate by the term of "teletactile audition." The adjective in this phrase is analogous to "telephonic" and the like. The noun is not intended to convey the idea that we are observing an auditory process in the ordinary sense; but that in the identification of words and sentences we are taking advantage, through the sense of touch, of the very vibrations that occasion hearing in persons of normal sensory equipment. Furthermore, the noun "audition" is meant to convey the idea that subjects who are highly practiced in "teletactile audition" have developed an imagery of touch in terms of which they remember, think and imagine; that in this respect they run parallel to the rest of us, who imagine, think and remember in what we call auditory terms. Certain tactual imagery is substituted for certain auditory imagery that would have developed but for the fact that appropriate stimuli found touch organs in the skin in lieu of auditory organs which did not exist. It is fundamental in our thinking about the problem that the psychologic process of attaching meanings to impressions received from a given source through a normal ear is precisely the same as that by which meanings cluster around impressions received from the same source and that come into consciousness as touches upon the skin or as vibrations of the solid structures of the body that enter into sensory experience.

2. The second hypothesis: it is possible to employ the same tactual factors as cues to the deafmute to gain control of his own voice.

Now I shall go on to present some new data that have accumulated since October, 1925.

It is one thing to demonstrate the possibility of circumnavigating the moon, and quite another thing to show its practicability. To do the latter, one must prove (among other things) that the deed can be done in reasonable time.

The chart below presents a learning curve (D. C.), that shows what one subject has been able to do toward mastering ten vowel and diphthong qualities in twenty laboratory sessions of approximately forty minutes each, one session daily, five days a week.

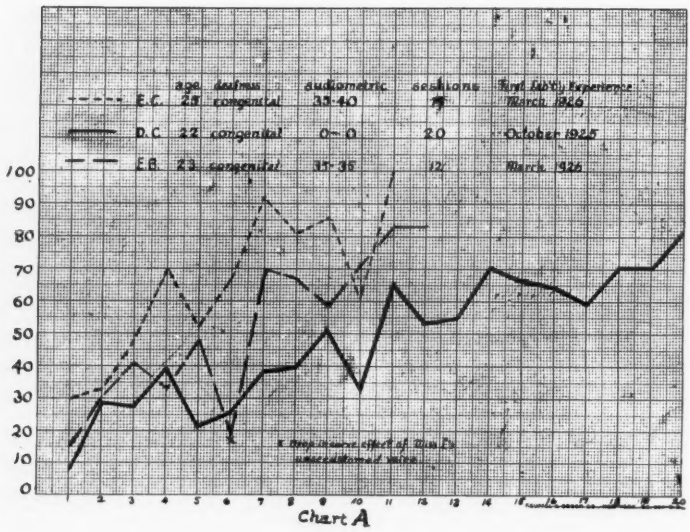

Chart A

This subject is a young woman, 22 years of age, a sophomore in college in Washington, D. C. Audiometric tests indicate no hearing in either ear. Her condition is described as congenital. Her general behavior, aside from speech, is that of a normally alert young woman. She had never been inside our laboratory prior to October 16, 1925, and on that day she began the course of learning that is illustrated in the chart above. On the twentieth session she attained to an accuracy

of 82 per cent in the identification of vowel and diphthong qualities A, E, I, O, U, Oi, Ou, Er, Oo, Aw.

The method of training was as follows: the characters and combinations of characters as written above were placed upon a blackboard before her. The experimenter, out of sight in a distant room, pronounced the qualities as represented into the transmitter. (A, I and U were pronounced as diphthongs; E as in "eat"; O as in "boat"; Oi as in "boil"; Ou as in "bout"; Er (middle western) as in "refer"; Oo as in "boot" and Aw as in "awe." Twice the experimenter pronounced for drill while an assistant by the blackboard pointed to each character in turn as the voice came through the instrument, all the while drawing the attention of the subject to the feel upon her finger tip. As soon as this preliminary drill had been completed the experimenter proceeded to pronounce once more, naming each character in an unknown order. The assistant was no longer at the blackboard. The subject attempted to write upon her pad the character that was represented by each successive tactual impression. About fifteen seconds elapsed between two pronunciations. After ten impressions the experimenter checked up so that the subject knew exactly what success she had met. Thereupon brief drill occurred as before, and ten impressions followed in an unknown order. Usually eight to ten series were presented for identification in each experimental session. No more than an aggregate of seven or eight hours were spent in the course of the twenty sessions in drill and in actual attempt at identification.

Compared with the learning curves of other subjects in our laboratory prior to October, 1925, this one rises rapidly. But since the last of the twenty sessions of which I have been speaking we have greatly improved the technic. One illustration of the effect of better technic is found in the rapid rise of the curve for E. C. in Chart A. In eleven sessions of forty minutes each E. C., a young woman of 25 years, a junior in college, whose audiometric record is 35 and 40, has advanced to perfection in the identification of the ten tactual complexes to which I have referred. This subject came into our laboratory and began training on March 25, 1926. Of course, personalities are of such complicated patterns that it is a precarious adventure to compare one with another, and in a case of this sort

one cannot in entire intellectual honesty declare that the difference in the two curves is due to difference in technic alone. In this instance comparison is on the less secure ground, because E. C. was a subject in our laboratory one-half hour daily, five days weekly, with fair regularity from October 8, 1924, to March 12, 1925. From March 12 to May 5, 1925, she attended very irregularly and was present only eleven times. During this period she had a little experience with the first eight of the ten vowel and diphthong qualities that have been named above. From May 5, 1925, to March 25, 1926, the subject had not been inside our laboratory. All this interval was a period of no practice, during which she had an unparalleled opportunity to forget what she had learned.

Better illustrations of the effect of improved technic are found in the course of three young men, all deafmutes, who came into our laboratory on March 25, 1926. Prior to that date they had no knowledge whatever of our procedure, excepting as they may have picked it up by conversation with our laboratory subjects. In the twelfth session these young men made records as follows: 83 per cent, 72 per cent, 50 per cent, 50 per cent and 33 per cent. (The last made 45 per cent in the eleventh session.)

The learning curve representing the progress of the most successful of these subjects is represented in Chart A (E. B.).

Before passing on to other evidences of the rapidity of learning to identify speech sounds by their tactual correlates I offer Chart B below, which is a crude, albeit apparently effective, representation of the tactual correlates of our ten vowel and diphthong qualities. The differences among the figures as illustrated here have grown out of our subjects' own descriptions of their tactual experiences.

The thickness of the lines indicates relative heaviness of the tactual impression. A straight line represents a continuous unbroken feel. Other lines represent impressions that are broken or that change from beginning to end. The direction of a line is our own sign of rising or falling pitch.

Now with the chart before the subjects on the wall, we first ask each one to indicate whether an impression is in the first group—continuous—or in the second—broken. In the next

place we have them designate where it belongs in the group. If it is in the second the fact that it is heavy or light (low or high pitch) at the beginning or heavy or light at the end, presents an important criterion as to its positive identification and interpretation. The method presents a line of least psychic resistance.

Additional encouraging evidence relating to the speed with which tactual discriminations among speech sounds may be

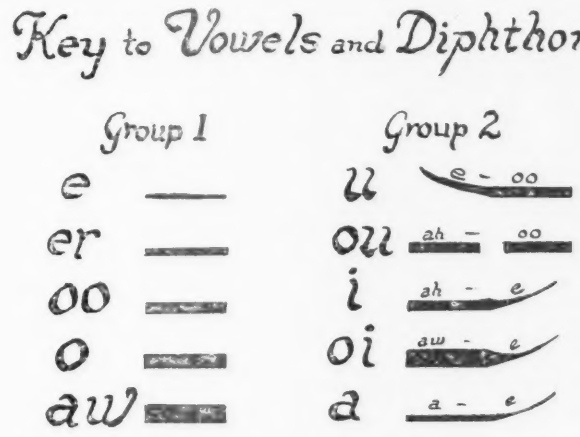

Chart B

acquired is found in the Archives of Oto-Laryngology, already cited, where we have presented a learning curve that shows the average progress of four subjects in learning 58 isolated words in the course of forty half hour sessions. In the same place is a statement concerning the skill of the same subjects in grasping the meaning of 117 unfamiliar sentences composed, each one, of a group from among the 58 words.

But experience has brought greater rewards than are indicated there; this time in relation to 120 sentences such as we employ in colloquial speech. I should say that the results I am about to show respecting the rapidity of learning to recognize

these sentences by their feel are incidental products of an experiment that has long been engaging our attention and that is aimed at the use of the tactual stimuli from speech as aids in the process of lip reading. I shall presently report the progress of this aspect of the enterprise.

The routine of the experiment includes taking the written reports upon the 120 sentences literally, as felt one after another, but not seen upon the lips of the experimenter.

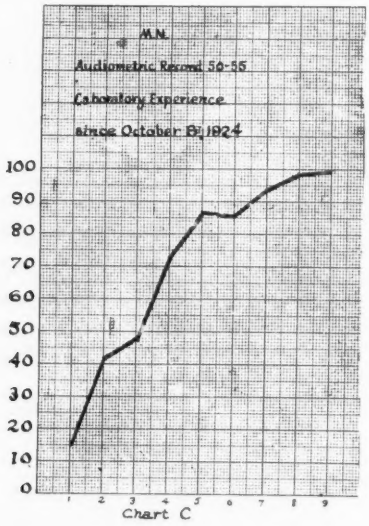

Chart C

When the entire list of sentences has been repeated the ninth time one subject (Chart C) had established a record of 100 per cent of identifications, though she had had but an aggregate of 120 hours of experience in the laboratory prior to the beginning of this portion of the work on January 29, 1926. Another (Chart D) attained to over 90 per cent of a perfect performance at her best, though on January 29th she had had an aggregate of only 80 hours in the laboratory since she first entered it. A third (Chart E) attained 22 per cent after an aggregate of 40 hours.

"Identification" of a sentence in this connection means a literally correct report.

It became evident in the course of exercises upon these sentences that the subjects were developing a tactual imagery: a capacity to remember and to think in terms of the felt characteristics of the sentences. Indeed such a result may be taken for granted in view of the fact that subjects learn and do well at remembering what they learn.

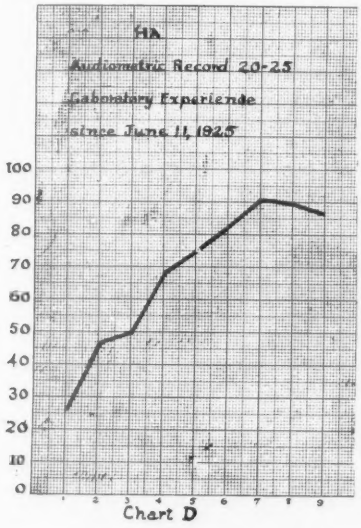

Chart D

Now that several of our subjects have arrived at a high level of efficiency in respect to the 120 sentences, in order to maintain their attention and interest at a high level we began on April 1st introducing new sentences—ten at the outset. Immediately upon the occurrence of a new sentence our subjects—at least those who are designated on the charts above—recognized it as different from those upon which they had been drilled, and they experienced little embarrassment thereby. This for a reason that I have not yet related: in the course of daily drill they have had a deal of experience in feeling the quality and tempo of many phrases (prepositional, e. g.) and

clauses, and they have learned to report with a fair degree of accuracy, furthermore, what long or broad vowel qualities and diphthong qualities are contained in new or unfamiliar tactual words. Not only so, but they very frequently recognize a vowel-consonant combination. Taking all together, they obtain many a cue by means of which they can make a good jump at the meaning of a new sentence. I have already published a report upon their ability to identify, by touch alone, words that they

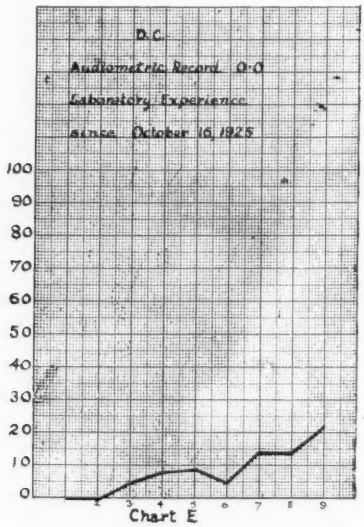

Chart E

have never felt before, provided only that a list of such words is upon a chart before them, already marked, to bring to their attention elements with which they have had a deal of tactual experience. Indeed our most successful subjects will do fairly well today at picking up a conversation by means of its feel instrumentally communicated to their skin, provided they know the topic of conversation in advance and the nature of the subject matter. All this may be described properly as evidence of a developing synthetic capacity, and again, in a broader sense, as evidence of teletactile audition.

But I must hasten on to a matter that, in my opinion, is of very great immediate practical importance. I refer to aid to the lip reader. We have now demonstrated four times that if a subject can simultaneously see the face of a speaker and feel the speaker's words and sentences, he can interpret speech to upwards of more than 100 per cent better than he can do by observing the face alone. Obviously, the most expert speech reader will profit less by a conjunction of touch and vision than the less expert. But even one of the most accurate speech readers in Washington gains a little by the combination, while an extremely mediocre one jumps to the level of the very expert. The average of increased efficiency on the part of the entire group is approximately 60 per cent. I am speaking now of the interpretation of sentences. The combined method affords a more accurate identification of isolated words, also, than does the method of unaided lip reading, or speech reading, as some prefer to call it. The advantage of the combined method in relation to isolated words is approximately 23 per cent.

Results of this sort should occasion no great surprise, in view of all their forebears in our laboratory. For example, in the article in the Archives there was a brief statement of the results of certain experiments with homophonous words—that is, words that look alike on the lips of a speaker—such as "aim—ape," "make—bake." It has been estimated that there are in the neighborhood of 2,000 such words in the English language. We have made experiments with 307 such words that occurred in 103 groups. We selected the groups at random. Of these words, 138 occurred in pairs; 30 in groups of three; 24 in groups of four; 30 in groups of five; 30 in groups of six; 28 in groups of seven. Finally, there was one group of eight, nine and ten, respectively. The question was whether our subjects could, by feel, distinguish words that look alike. Obviously the presumption is in favor of an affirmative answer, and experiment supports the presumption. Of the 103 groups there are only nine (including 29 words) in which our subjects were not able to make a good report in attempting to make distinctions by touch. Other experience makes us confident that with practice satisfactory results might have been got even in relation to these groups. Very little preliminary

practice was had in this section of our total experiment. In fact, the experimenter read a group of words but three times, in a known order, into the fingers of the subjects so as to give them a slight acquaintance with the tactual qualities of the words respectively. Thereupon the same words were pronounced in an unknown order, the subjects meanwhile trying to report, after each impression, what word had been pronounced. When the subjects had had twenty opportunities to make a report another group was handled in the same manner, and so on till the trial of the 103 grounps was completed. The average per cent of identification of words within all groups was 71.5 per cent.

At the same time that we were trying these words for tactile identification, we undertook to find how far our subjects could go toward identifying the same words by observing the lips and face of the speaker without tactile impression. The method of this test was exactly analogous to that already described. First, the words were read three times in a known order for drill, the subjects being seated directly before the speaker. They were then pronounced in an unknown order until there had been twenty opportunities for identification. For all 103 groups the average superiority of tactile identification over that by lip reading alone was 22.8 points. The range of differences from which this average was computed was from minus 5 to plus 65.

It should be said in this connection that if the words in our 103 groups, respectively, are strictly homophonous, they should be identified by the lip reader in no more than a chance number of cases. Only 49 of the groups fulfill this criterion, and in no one of the 49 did our subjects fail to make considerably more than a chance number of identifications.

In our laboratory experience with homophonous words, then, is one explanation of the fact that seeing speech upon the lips and feeling it simultaneously—i. e., receiving speech through two departments of sense at the same time—greatly increases the accuracy of interpretation.

But this is not the only factor that is involved here. There is a certain affective element that normally hearing people find associated with spoken language. It attaches even to silent reading. It is entirely probable that it has arisen from our

experience with the movement or swing of spoken language: its emphasis, accent, rhythm, and its varying tempo. The pleasurableness of speech, as we hear it, comes very largely from our sensing all of this, and, of course, also from vocal quality as we get it through the sense of hearing. All this swing of speech affords not only an effective experience to the hearer; it contributes also very greatly to his understanding. But it is next to impossible for the deaf lip reader to have advantage of the swing or movement of speech. Its trippingness is nothing to them. They are short, therefore, in both understanding and pleasurable experience. The sense of touch is a doorway through which speech steps along with something of its normal gracefulness. Our subjects have become very familiar with the way in which sentences are spoken and read. They know, for example, that preposition phrases are ordinarily spoken rapidly in relation to other portions of a sentence. They understand the rudiments of emphasis and accent, too—that is, they know where emphasis and accent will occur when a sentence is spoken. They can mark a group of sentences with which we have had nothing to do in laboratory practice so as to indicate fairly well the emphasis, rhythm, pauses and varying tempo that a good reader would put into them. Subjects who have had no practice in our laboratory are, on the whole, 28 per cent inferior to our trained group in this respect.

Herein is another reason for the superiority of interpretation of speech when the deaf add the feel of spoken language to the vision of moving lips and face. They can learn to distinguish the movement of speech and at the same time they can understand by tactile means very many words that cannot be understood by vision of facial expression alone.

This result from our laboratory practice brings us face to face with a practical consequence of no mean order, namely, we shall certainly be able to develop our method ultimately to the end of speeding up instruction in the schoolroom for the deaf in every relation in which spoken language is employed. It is, furthermore, of no small consequence that our method admits of handling simultaneously not just one, but a group of subjects, whose number is limited only by the number of receivers available and by the current from the batteries.

At this point I am tempted to state two hypotheses:

1. After training for a year in a school for the deaf in which our method is in use, a successful subject who has a fair capacity for speech, should be able to take his place in a schoolroom occupied by normally hearing pupils and to make progress there, assuming that the room is fitted with an instrument for his use.

2. After sufficiently prolonged training in this method, a subject should be able to put the instrument aside without sacrificing all the advantage that arises from its use. I mean that he should be the better unaided lip reader because of having used it. A preliminary support of this hypothesis is found in the experience of normally hearing people. Because we have ourselves spoken millions of times, and especially because we have heard others speak daily since our earliest infancy, we have developed a language sense. We expect emphasis, accent, rhythm, changes in tempo and inflection, each in a certain type of connection. We catch in advance verbal and other signs of impending emphases, variations of tempo, etc. All of this helps us to grasp the meanings of spoken discourse and of the printed page. By the same token, the deaf should be assisted in unaided lip reading when they, too, have been saturated with a language sense, even though they must acquire it by way of the sense of touch.

Obviously neither of these hypotheses can be tested thoroughly without a long period of experimentation.

We must not minimize the enjoyment that our deaf cases are obtaining from the movement of speech as they feel it. The swing of verse is a source of pleasure for them.

> "How does the water
> Come down at Lodore
> From its sources that well
> In the tarn by the fell?"

Is a movement that is particularly enjoyable; and it is very difficult to bring the deaf who rely upon their ordinary means of communication to enjoy verse. It is the sense of movement (the kinesthetic sense) plus the feeling of the individual words that afford the enjoyment, and not the movement alone. The first two of the Lodore verses above from Southey are

consistently reported as more pleasurable than the following from Stevenson that has the same movement:

"How do you like to go up in a swing?

Evidently the quality of the vowels that predominate in the first two verses from Southey, contrasted with the predominating vowel quality in Stevenson's verse, are the factors that occasion the difference in pleasurableness. I say "evidently," because when we make up ten verses of nonsense syllables as follows—

"Ray, ray, ray," etc.
"Ree, ree, ree," etc.
"Ri, ri, ri," etc.
"Ro, ro, ro," etc.
"Raw, raw, raw," etc.

Each verse composed of R combined with one of the ten vowel or diphthong qualities that I have referred to in an earlier connection, and when these nonsense verses are pronounced in the same swing as the Lodore verses subjects almost consistently describe some as more pleasurable than others. The "Ro, ro, ro" verse, for instance, surpasses all others in this respect. It is not that "Ro" is felt most distinctly, for "Raw" surpasses "Ro" in this regard.

Observations of this nature suggest another hypothesis: namely, that we may be able to communicate some sequences of musical sounds to our subjects in such a manner that they may be felt "in the bones" and enjoyed. Casual observation already affords some support for this hypothesis; for occasionally we find a totally deaf person who declares that he enjoys the church organ. He feels its vibrations communicated through the floor of the building. I have employed a vigorously acting receiver against the chest of one subject for the purpose of making preliminary tests of this hypothesis. I hope I may find a favorable opportunity to make a thorough examination of this fascinating supplementary problem.

NOTE.—I am obliged to the Bell Telephone laboratories for the loan of instruments used in these experiments and to my assistants, George Crane, Marné Lauritsen and Helen Austin, for their careful cooperation.—R. H. G.

LXXVIII.

CHRONIC FOCAL INFECTION OF THE TONSILS AND ACCESSORY SINUSES IN ADULTS.*

By Judson Daland, M. D.,

PROFESSOR OF MEDICINE, GRADUATE SCHOOL OF MEDICINE, UNIVERSITY OF PENNSYLVANIA,

Philadelphia.

A conjoint meeting of four American societies, representing leaders in their respective specialties, is unique, and will exert a profound and beneficial influence upon the medical profession. To be invited to participate in this meeting is not only a great privilege but also a fourfold honor.

Miller's[1] book on the microorganisms of the mouth, published in 1889, first aroused my interest in focal infection. Billings[2] showed the relationship of focal infection to internal medicine, and the indefatigable Rosenow,[3] who has done far more original work in this field than any one man, has placed it upon a sound foundation by his brilliantly conceived and well executed series of animal experiments, proving the variability, virulency, pathogenicity, selectivity, and transmutability of the streptococcus under varying oxygen tension. Hunter[4] was the first to make known the relationship of focal infection to pernicious anemia. My first communication was in 1912,[5] and in the following year I reported cases of systemic disease[6] secondary to chronic infection of the tonsils, at a meeting of the Philadelphia Laryngological Society. In recent years a host of workers have discovered additional evidence, proving that focal infection causes many systemic diseases.

My observations shall be limited to chronic or latent infection of the tonsils and accessory sinuses in adults.

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*Read by invitation, as a part of a Symposium on Focal Infection, at a joint meeting of the American Laryngological, Rhinological and Otological Society, the American Otological Society, the American Laryngological Association, and the American Bronchoscopic Society, held in Montreal, May 31, June 1 and 2, 1926.

The following summary of diseases, based upon cases observed in hospital and private practice during the past twenty-five years, is given in order to emphasize the etiologic relationship of chronic infection of the tonsils or sinuses in adults to systemic disease:

Nervous system: Meningitis, encephalitis, bulbar palsy, chorea, neurasthenia, psychoses, diseases of the spinal cord, cranial and peripheral nerves.

Bones, joints and muscles: Arthritis, osteitis, periostitis, synovitis, tendovaginitis, myositis.

Alimentary system: Gastric, duodenal and intestinal ulcer, gastritis, enteritis, cholecystitis, gall stones, cholangitis, hepatitis, pancreatitis, and appendicitis.

Circulatory system: Peri-, myo- and endocarditis, hypertension, aortitis, thrombosis, embolism, anemia, and pernicious anemia.

Genitourinary system: Nephritis, pyelonephritis, calculus, prostatitis, seminal vesiculitis, endocervicitis, and sterility.

Respiratory system: Bronchitis, bronchiectasis, pneumonia, bronchopneumonia, lung abscess, pleuritis, and asthma.

Skin: Acne, furunculosis, carbunculosis, alopecia, herpes, herpes zoster, urticaria, pruritis, dermatitis, and ichthyosis.

Diseases of the eye, ear, nose and throat will be fully discussed by Drs. Byers and Goldsmith, but mention may be made of conjunctivitis, keratitis, corneal ulcer, iritis, optic neuritis, uveal tract disease, impaired hearing or deafness, tinnitus, vertigo and Meniere's disease.

Focal infection is a frequent complication of many diseases, as for example, tuberculosis, syphilis, influenza, and diabetes.

This condensed summary resembles the table of contents of a textbook on the practice of medicine.

One of the causes of any one of the diseases mentioned is a bacterium, a toxin, or both, from a focus of infection in the tonsils or sinuses, which infection cannot be ameliorated or cured by drugs if the focus be not eradicated, hence the vital interest of the internist in the specialties which this conjoint meeting represents.

The importance of rhinolaryngology has perhaps been doubled by the recognition of the principles of focal infection and the value of surgical treatment.

The indifference and skepticism of a number of ultraconservative laryngologists is responsible for avoidable tragedies.

The portal of entry of infection in the head cavities, in adults, more or less in the order of frequency, is the teeth, tonsils, sinuses and pyorrhea, and two or more of these foci frequently occur simultaneously. The tonsils and teeth are ideal locations for foci of infection, because the areas involved are closed and deprived of oxygen. Pyorrhea around the third molar, or sinusitis, may infect the tonsil directly or by the blood stream, whereas the teeth infect the tonsil by the blood stream alone. The lingual tonsils and hypertrophied pharyngeal glands only occasionally cause systemic disease.

The tonsils or sinuses may be primarily infected by influenza, diphtheria, scarlet fever, streptococcic milk, cream or cheese, or by contact with a case of acute tonsillitis or a carrier. The tonsils may be secondarily infected by sinusitis, mastoiditis, otitis or conjunctivitis. The streptococcus may be harmless to a carrier and virulent when transferred to a new host.

Microorganisms, usually few in number and apparently harmless, are always found in the mouth and on the surface of tonsils, but when streptococci are confined in the bottom of a crypt, closed by adhesive inflammation, and deprived of oxygen, they gradually acquire virulency, pathogenicity and selectivity, which acquired characteristics may again be lost in the presence of oxygen.

Infected tissue no larger than a small French split pea is sufficient to cause fatal systemic disease, and no relationship exists between the amount of infected tissue and the seriousness of the secondary disease. When a portion of an infected tonsil remains after a tonsillectomy, with the crypts sealed, recurrence of systemic disease is common, and the beneficial results of the operation, if any, are usually temporary. These observations emphasize the importance of complete eradication or free drainage from all foci of infection.

Intercurrent infections, such as influenza, pneumonia, typhoid fever or varying degrees of susceptibility or immunity,

or factors now unknown, may convert a harmless into a harmful streptococcus.

Infected tonsils may remain a local infection, but, as a rule, even when symptoms are absent, toxins or streptococci may enter the blood intermittently or continuously.

When the amount of toxins or microorganisms is small, or the cellular or humoral immunity great, symptoms may be absent. Systemic symptoms appear when the disease in the tonsil increases, local resistance decreases, or when general immunity is lessened by intercurrent acute disease, long continued physical or mental stress or strain, malnutrition, anemia, diabetes, advancing years, or from causes unknown. In my judgment, toxins exert a far greater influence in causing systemic disease than is generally believed. Vaccines containing no live bacteria, or compression of the tonsils for diagnostic purposes, may cause an exacerbation of existing symptoms. Blood cultures, with few exceptions, are sterile, even when a chronic secondary disease becomes acute.

Bacteria, in their new environment in a secondary focus of infection, may acquire characteristics different from those in the primary focus. Toxins as well as bacteria possess selectivity.

Most of the diseases mentioned in the summary may become a secondary focus of infection.

The following history is often given by elderly patients with chronic infection of the tonsils or sinuses: In childhood, an attack of acute tonsillitis, diphtheria or scarlet fever, followed by apparent recovery; between childhood and manhood, occasional attacks of mild or severe tonsillitis; between manhood and late in life, periods of latency, occasionally interrupted by acute tonsillitis during an epidemic of influenza or pneumonia. At or about 50 years of age, systemic disease, which has been slowly developing, is at last diagnosed, and the tonsils are then removed with maximum suffering and risk.

Although infected tonsils do occasionally atrophy and become harmless, they usually remain infected, even as long as twenty to forty years.

My experience inclines me to the opinion that, as a rule, tonsils once infected are thereafter a menace and should be removed as a prophylactic measure.

A study of the blood by the author[7] showed that in 40 per cent of cases of systemic disease, secondary to tonsillar infection, the total number of leucocytes were decreased and the number of lymphocytes increased, with a proportional decrease in the polymorphonuclear cells, making a leucocytic picture of diagnostic importance.

In the absence of any other focus, the internist suspects chronic infection of the tonsils in an adult, when a disease occurs that may be due to that cause, as for instance, myocarditis, cholecystitis, arthritis, neuritis, etc., and this suspicion becomes a strong probability if leucopenia, lymphocytosis, decreased polymorphonuclear cells, usually in association with anemia, are also present.

The diagnosis of chronic or latent infected tonsils in adults has been discussed by the author[8] elsewhere, and may be easy, difficult or impossible.

In diagnosing infected tonsils, the internist attaches importance to a history of diphtheria, scarlet fever, quinsy, recurring tonsillitis, recurring sore throat, recurring rhinitis, enlarged cervical glands, a congested or beef-like appearance of the anterior pillars, the appearance of the tonsils, and the presence in pure culture of the streptococcus viridans or hemolyticus in materials obtained from the bottom of a crypt. These streptococci, when injected into animals, may reproduce the disease from which the patient is suffering.

A hypertrophied tonsil, causing mechanical difficulties because of its size, may be less dangerous than a small buried tonsil. As a rule, an intra- or retrotonsillar abscess is not diagnosed. The diagnosis of an infected tonsil is finally established after a consultation with a laryngologist.

Systemic disease, secondary to chronic infection of the accessory sinuses, is usually less frequent and less severe than when the focus is in the tonsils or teeth. When a focus in a sinus is closed, secondary disease may be most serious.

The ethmoid is more frequently a focus of chronic infection than the sphenoid, but both sinuses and the tonsils may be simultaneously infected. Maxillary sinusitis is less frequent than a paranasal sinusitis.

The internist suspects chronic sinusitis in adults, when a disease occurs that may be due to a focus of infection; when

there is a history of diphtheria, scarlet fever, recurring influenza or rhinitis; when leucopenia, lymphocytosis and diminution of polymorphonuclear cells is present; when no focus of infection exists elsewhere, or when infected tonsils are present, because infected tonsils and sinuses frequently coexist; when postnasal discharge, usually mucopurulent, occurs each morning; and when cultures from the sinus show pathogenic bacteria.

The diagnosis of chronic infection of the accessory sinuses is difficult; when the history gives little or no information; when partial drainage prevents symptoms of pressure; when nasal obstruction prevents direct examination of the ostium of the ethmoid or sphenoid; or when secretions are absent or unobtainable by irrigation or suction. As Skillern[9] well says, the absence of pus proves nothing; its presence is diagnostic. Cultures from a sinus which is normally sterile may show bacteria, even in the absence of visible secretions.

A sinus may contain mucopus and be transparent to the X-ray, and the mucous membrane of the walls of the cells of a sinus may be hyperplastic, polypoid and infected, without secretions, and the X-ray may or may not show this thickening.

Occasionally, a probable diagnosis of infected tonsils or sinus may be made by exclusion, when a syndrome occurs that may be caused by a focus of infection, in the absence of any other focus. Diagnosis by exclusion is difficult and uncertain.

A negative opinion as to sinusitis should never be given until two or more direct examinations have been made, and occasionally a positive diagnosis is possible only after an intercurrent rhinitis or influenza has converted a latent into an active sinusitis.

In chronic ethmoiditis, the adjacent cells, owing to their peculiar anatomy, may be infected, and the communicating canal or ostium obstructed or closed. Failure to obtain good results, even after good drainage has been secured by one or more operations, may be due to a closed infected ethmoid cell.

The special complications of paranasal sinusitis are diseases of the orbit, optic nerve, meninges and venous sinus. A final diagnosis is made after consultation with the rhinolaryngologist.

The biologic conditions under which bacteria live in chronic sinus infection differ markedly from that of the teeth or ton-

sils, and more nearly resembles that of pyorrhea, with pockets more or less shut off from the air in the buccal cavity.

The streptococcus, staphylococcus, pneumococcus and other bacteria are frequently present in secretions from infected sinuses, but seldom in pure culture. Ordinarily, more or less air is present, and, therefore, oxygen tension is higher than in tonsillar and dental infection, with consequent diminution of infectivity and specificity, excepting when the sinus is completely shut off from communication with other parts of the sinus.

The treatment of tonsillar or accessory sinus infection is surgical, and success depends upon the complete eradication of all foci of infection or free drainage.

My experience has been limited to autogenous vaccine, made from bacteria that caused the disease. Cultures should be made immediately after the removal of the tonsils or immediately after material has been obtained from the sinuses. The predominating bacteria that produced systemic disease should be promptly cultured with as few transplants as possible, as bacteria tend to lose their specific characteristics after a number of transplants, and a vaccine made therefrom is less efficient.

A vaccine is of undoubted value in the asthenic, emaciated, diabetic and the aged. The young and vigorous adult seldom requires a vaccine. When a focus of infection exists, the beneficial influence of a vaccine is usually partial and temporary, but when removed, or when good drainage has been secured, recovery is hastened.

A violent reaction should be avoided; it indicates that the dose of vaccine was excessive.

Occasionally a vaccine may temporarily aggravate the symptoms produced by secondary disease.

Failure of vaccine treatment may sometimes be due to marked changes in the characteristics of the bacteria in the secondary focus, caused by change of environment.

The dose of vaccine should be accurately measured and aseptically administered hypodermatically, at intervals of five days, for ten doses. The first dose should be 0.1 cc., or 100 million bacteria, so that the reaction will be mild, if hyper-

susceptibility exists, and each dose thereafter should be increased 0.1 cc. The vaccine should be kept in a refrigerator.

As chronic or latent infection of the ethmoid or sphenoid is sometimes not diagnosed by the rhinolaryngologist, may I earnestly recommend that researches be made by one or more members of this meeting, with the object of discovering new and more reliable diagnostic signs?

SUMMARY.

1. Latent or chronic infection of the tonsils or sinuses is not uncommon in adults.

2. Scarlet fever, diphtheria, influenza and streptococcic milk in childhood are often the primary causes of latent or chronic tonsillitis diagnosed late in life.

3. Systemic disease, secondary to chronic infection of the tonsils or sinuses, is associated with leucopenia, lymphocytosis and diminished polymorphonuclear cells in about 40 per cent of the cases.

4. The presence in pure culture of the streptococcus hemolyticus or viridans in the bottom of a crypt of a tonsil is diagnostic, the importance of which is increased when injections into animals prove that the streptococci possess pathogenicity and selectivity.

5. The presence of bacteria in sinuses possesses additional diagnostic value because these regions are normally sterile.

6. Latent or chronic sinusitis is often an unsuspected focus of infection and often coexists with infected tonsils and teeth.

7. A negative opinion in suspected chronic sinusitis should only be given after repeated examinations.

8. Closed infected ethmoid cells may be the cause of postoperative failure, even when free drainage has been secured.

9. Autogenous vaccines are valuable in asthenia, emaciation, anemia, and the aged.

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LXXIX.

TUBERCULOSIS OF THE MIDDLE EAR AND MASTOID.*

By Frank R. Spencer, A. B., M. D.,

Boulder, Colo.

The frequency of middle ear suppuration in patients with pulmonary tuberculosis was realized as early as the middle of the last century by Toynbee[1] and von Troltsch.[2] Wilde[3] had noticed the painless onset of tuberculous otitis media, followed by discharge, and the peculiar appearance of the membrana tympani, thirty years before the discovery of the tubercle bacillus by Koch in 1882. Eschle[4] found tubercle bacilli in the discharge from the middle ear in 1883, and Habermann[5] first demonstrated giant cells and tubercle bacilli in the tympanic mucous membrane.

Politzer,[6] in 1865, described the characteristics of tuberculous otitis media. Politzer[7] later made a histologic examination of the middle ear and described his findings in 1882. Schwartze[8] described in 1878 small tubercles in the mucous membrane. However, the disease does not receive the serious consideration which it deserves, as a study of the literature of the subject shows, and the diagnosis, in the milder types, is likely to be overlooked. The etiology of all cases of suppurative otitis media should be determined whenever possible.

Tuberculosis of the middle ear is more frequent than is generally supposed, because it is easily overlooked, even in patients suffering from pulmonary tuberculosis. This is attributable to two things: First, the absence of pain, which usually forces the patient to seek the otologist's advice; and second, when mixed infection is present the real cause, viz., the tubercle bacillus, is not easily obtained from the pus.

Mathews[9] says, "There are numerous considerations which combine to render tuberculosis of the middle ear and temporal

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bone a subject of great interest and importance, both clinically and pathologically. The number and variety of the channels through which infection may take place, the frequency of the condition, its occurrence in infants, the gravity of the condition and of its possible complications, the multiplicity and diversity of its signs and symptoms, the urgent necessity for drastic treatment, the possibility of absolute diagnosis and ultimate cure are the most important of these consideration."

The history is often quite typical, because the patient will tell you that the first thing he noticed was a feeling of moisture in the external auditory meatus and that, when he placed his finger in the canal, he encountered pus. Mathews[9] says, "The absence of pain is not peculiar to this condition, but is found in tuberculous osteomyelitis of any bone prior to the involvement of surrounding structures or the advent of mixed infection." Tuberculous lesions are generally free from pain, and tuberculous otitis media is no exception.

Mathews[9] furthermore says, "The occurrence of discharge from the ear is not infrequently—in the absence of pain—the earliest symptom noticed. This discharge presents many points apart from its mere chronicity and the absence of associated pain, which may justly raise suspicion that the case is tuberculous."

An additional history of pulmonary tuberculosis serves to put the otologist on his guard. Tuberculosis of the middle ear can and does occur, of course, in patients who have not had pulmonary tuberculosis. The complete absence of pain preceding the discharge is a very important point in the history. If pain is present, this is nearly always caused by mixed infection. The number of pus producing organisms naturally determines the amount of pain. If there is severe pain preceding the discharge of pus, the tuberculous etiology can the more easily be overlooked unless a careful bacteriologic examination is made. Robinson's[10] patient had tinnitus before the drum ruptured, but no pain. The absence of tubercle bacilli at the first examination counts for very little. Personally I have not obtained a history of pain if the otitis media was caused entirely by tubercle bacilli. Leegaard[11] believes pain is nearly always present preceding the discharge, but perhaps his patients had a mixed infection.

Briggs[12] mentions the possibility of an ear infection originating through the lymph channels from a brain tubercle. Graham,[13] in commenting upon this, says, "It is interesting to note that Habermann[14] has since described such a case." However, extension from the brain must be rare indeed. Infection, especially in infants, but in adults as well, must frequently reach the middle ear and mastoid through the eustachian tube. At least in adults suffering from pulmonary tuberculosis and with sputum laden with tubercle bacilli, this mode of infection is likely the most frequent. The tube is shorter, more nearly horizontal and more patent in infants than in adults. Metastasis through either the lymph or blood stream must be important. In infants and young children tuberculosis of the lymph glands is frequent as compared to pulmonary tuberculosis. Therefore, infection may take place through the lymph channels. Infection from the external auditory meatus, when a perforation has previously existed from other causes, is quite possible. Emphasis has often been placed upon the fact that the tonsils and adenoids become infected, first, with secondary foci in the temporal bone. Other avenues of infection may, in occasional cases, be important, but time will not permit of a free discussion of all of these at this meeting.

Examination of the affected ear often reveals a small amount of thin seropus along the floor of the canal, in some instances obscuring a good view of the drum. After the seropus has been wiped away, multiple perforations are usually found in the membrana tympani. These are often very small perforations, but they may gradually increase in size during the subsequent months. If several coalesce to form one larger perforation or even two or three larger perforations, the picture becomes less and less typical. Granulation tissue, about the margins of the perforations, is more frequently encountered than in nontuberculous suppurative otitis media. Gaudier[15] regards the presence of profuse granulations as a suspicious sign. However, there are many exceptions to this. The granulation tissue is paler and consequently less vascular than when caused by other than tubercle bacilli. The tendency of staphylococci to invade the middle ear, from the canal, in any patient with suppurative otitis media of a few weeks' duration, is well known.

The mastoid is rarely tender in the early stage of the otitis media and may not be invaded by the tuberculous process beyond the antrum for months or even years. This is especially true in patients suffering from pulmonary tuberculosis. In fact, the mildly insidious onset is one of the chief characteristics of the disease in adults. Patients with incipient pulmonary tuberculosis often have enough immunity to prevent an acute onset. It is not uncommon to see the disease remain confined almost entirely to the middle ear, in adults, for years. Rough bone is not found upon examination with a probe; the ossicles are not necrotic; there is very little discharge, and very little granulation tissue. The rentgenograms of the mastoid show, from time to time, only a slight cloudiness, and the hearing is quite good.

In contrast with these mild types are those of greater severity in patients with advanced pulmonary tuberculosis and consequently poor resistance. Mixed infection also favors a severer type of otitis media. The perforation is larger, there is more granulation tissue, more pus; there is rough bone; there are necrotic ossicles, more loss of hearing and a more rapid invasion of the mastoid. Rentgenograms of the mastoid often show second and third stage mastoiditis.

The severest types of tuberculosis of the middle ear and mastoid are usually encountered more frequently in infants than in adults, and the cervical glands are also tuberculous. The disease spreads rapidly from the middle ear to the mastoid and often involves the whole temporal bone. The membrana tympani and ossicles are rapidly destroyed, so that pieces of the ossicles are found in the pus. Sequestra of bone have to be removed surgically from time to time, and the cervical lymph glands also require removal. The temperature is often over 100° F. Paralysis of the facial nerve occurs in approximately 50 per cent of the patients, and the labyrinth, including both the static labyrinth and cochlea, is often destroyed. Meningitis is a frequent terminal complication.

Graham[13] has classified his cases as follows: "Lupoid, infiltrating, fungoid, necrotic, myringitis diffusa of Möller,[16] and fibrinoid." His classification is based upon the clinical pathology, found either at the time of operation or at the autopsy, and has much in its favor.

During the first few weeks of the disease the bacteriologic examination of the seropus may reveal tubercle bacilli. However, repeated examinations by a competent bacteriologist may fail to find even a few tubercle bacilli. Failure to find tubercle bacilli in the discharge counts for very little. In fact, it has the same significance as failure to find the bacilli in sputum, but a positive finding is of great value. Staphylococci are easily found, but are misleading. They represent a secondary infection from the canal. The tubercle bacilli are prone to remain in the tissues of the middle ear, hence the difficulty of finding them in the discharge.

In 1911 I brought back from Berlin a small glass aspirator, devised by Dr. Max Halle, which is very useful for aspirating pus from the middle ear. The aspirator should be sterilized by boiling and the canal thoroughly wiped out and cleansed with alcohol. This aspirator fits tightly into the canal, and with the aid of the hand bulb a few drops of seropus can sometimes be obtained from the middle ear. If staining methods fail to show tubercle bacilli, a guinea pig experiment usually does.

Predisposing causes, either immediate or remote, are important factors. Immediate predisposing causes are as follows: Syphilis, either congenital or acquired; tuberculosis in other organs of the body—e. g., pulmonary tuberculosis in adults or tuberculosis of lymph glands or of bone in infants and young children; measles, scarlet fever; whooping cough; more rarely the other contagious diseases of childhood; sinus diseases; rickets; poor food; overcrowding; unhygienic environment; loss of sleep; lack of fresh air and sunshine, etc. Remote predisposing causes are as follows: Living with tuberculous people, nasal obstruction, diseased tonsils and adenoids, improper clothing, repeated colds, etc.

The examination made by the otologist is by no means complete without a thorough general physical examination by a competent internist, rentgenograms of the chest and mastoids, urinalysis, sputum examination, serologic tests, etc. In patients suffering from pulmonary tuberculosis, the primary focus is usually in the lungs; but in patients with normal lungs the primary focus is often in tuberculous glands. This is especially

true in children, because pulmonary tuberculosis is rare in children, while tuberculosis of the lymph glands is common.

When Dr. I. S. Fraser of Edinburgh was an honor guest at Atlantic City, N. J., of the American Otological Society, the American Laryngological Association and the American Laryngological, Rhinological and Otological Society, in 1923, I heard him make the statement that tuberculosis of the middle ear is frequently found in the children of Edinburgh, Scotland, because the Scotch dairy herds are not tuberculin tested, with the result that the milk often is infected with bovine bacilli. He showed many interesting slides of tuberculosis of the middle ear, mastoid and labyrinth. Ravenel[17] says, "Laboratory investigations have shown beyond question that bovine tuberculosis is transmissible to human beings and that the lesions produced do not differ in any way from those caused by human bacilli."

Otitis media is nearly always much more extensive in children than in adults. The mastoid or even the entire temporal bone may be involved. Long[18] has reported tuberculosis of the middle ear and mastoid in a baby of 11 months, cured by a radical mastoid operation. Graham[13] has reported tuberculosis of the middle ear and cervical lymph glands in an infant, with a fatal termination from a general tuberculosis, at 72 days of age. Large sequestra of bone may require removal surgically from time to time over a period of several years. The cervical glands are usually involved and may also require removal surgically. Crockett[19] has emphasized the swelling of the preauricular lymph gland. He says the cervical glands are less likely to recur, following their removal, if the middle ear and mastoid have been operated upon first in the case of small children. He advocates repeated operations, if necessary, to remove tuberculous foci from the temporal bone.

Horne[20] believes the early glandular involvement is the result of primary tuberculous middle ear disease and is rarely found in secondary involvement.

Leegaard[11] states that tuberculosis of the middle ear and mastoid is most frequently found in children from one to ten years of age. He believes paralysis of the facial nerve occurs in from 19 to 65 per cent of the cases. Milligan[21] found facial paralysis in 45 per cent of his series of tuberculous cases and

in only 2 per cent of his nontuberculous cases. However, Lake[22] encountered facial paralysis in four of 658 consecutive cases of suppurative otitis media. Grunert[23] believes facial paralysis is almost pathognomonic of tuberculosis of the middle ear and mastoid.

Levy[24] says, "The vast majority of suppurative processes in the middle ear occurring in tuberculous patients do not go on to destruction of bone; therefore, surgical measures have but limited usefulness." This corresponds, in a general way, with the experience of all of the otolaryngologists in Colorado, so far as I know, and at least with my own experience, except with children. In infants the disease is likely to be more serious.

Milligan[21] advises operation when the extent of the disease is not too great and the general condition of the patient not too hopeless.

The diagnosis is based upon the insidious onset; the absence of pain before the membrana tympani ruptures, except in patients with a mixed infection; multiple perforations in the drum; abundant pale granulations, and last, but not least, the finding of tubercle bacilli in the pus. The general physical examination, laboratory tests, rentgenograms of the chest and mastoid, are all important aids in diagnosis. Later in the course of the disease, fever, necrotic bone, bony sequestra, deafness, facial paralysis, etc., are only more positive evidences of the seriousness of the disease.

The prognosis in the mild type is usually very favorable, but is serious, at best, in the severe type. It is often wisest to keep such patients under observation for some time before making any very positive statements about the outcome. A guarded prognosis is better than hasty judgment.

The treatment decided upon as most suitable must of necessity be determined by the stage of the disease, the severity of the disease, the patient's general condition of health and age. The mild type requires daily cleansing of the external auditory meatus, as often as the pus collects, followed by instillations of 10 per cent phenol in glycerin, 2 per cent mercurochrome in water, 4 per cent protargol in water, etc. The patient's general health should receive every care and attention from an expert internist, preferably one skilled in tuberculosis.

Heliotherapy is of great advantage and can often be applied to the middle ear more easily than to the larynx. A large aural speculum, with as large an opening at the small end as can be comfortably maintained in the external auditory meatus, is best. The patient should secure an aural speculum, or should be shown how to make one from rather heavy and stiff white glazed paper.

The membrana tympani and middle ear should be exposed to the sun's rays, in the open air, for two or three minutes daily the first week. The exposures should be increased a few minutes each succeeding week until each daily treatment consumes from ten to twenty minutes. The ear of an adult should be pulled up and back, and the head of the patient, with the speculum in place, held so that the sun's rays can strike the drum and middle ear. The external auditory canal should always be cleansed immediately before each treatment.

Rest, fresh air, sunshine for the entire body, plenty of good food, climate, etc., are all important for the treatment of tuberculosis of the middle ear and mastoid, just as they are for tuberculosis in other organs of the body.

The severer types often require a mastoid operation, provided the patient's general health will permit. If the condition of the mastoid is not urgent, the operation often has to be put off until such time as the general health will permit. Crockett[10] favors surgical removal of sequestra of bone and tuberculous cervical lymph glands in infants as often as these form, over a period of several years. The severest cases require experience, mature judgment and surgical skill if a good result is to be obtained.

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PHYSICIANS' BUILDING.

LXXX.

HOW THE DEAFENED ARE HELPING THE OTOLOGIST.*

An Illustrated Discussion of the Local Work of Twenty-nine Branches of the American Federation of Organizations for the Hard of Hearing.

By Gordon Berry, M. D.,

Worcester, Mass.

We have asked ourselves the question, How can the deafened help the otologist? I find the answer in the varied and ramifying work being conducted throughout the country by the different constituent bodies or league members of the American Federation of Organizations for the Hard of Hearing. In order to avoid repetition, I will try to limit myself to the purely local phases and leave the broad and farseeing program of the national body for consideration before the Otological Society, day after tomorrow.

Many of you are familiar with the mechanism of this Federation. It began with the formation of local groups in individual cities, these groups usually being pupils gathered together under some lip-reading teacher. As these groups became stronger and better organized, the desire for making the movement country wide resulted in the unification of these organizations into a Federation, to which other local groups are added from time to time when their membership, financial status and enthusiasm are sufficient. Thus has grown up this American Society, which as yet includes no Canadian constituent bodies, though we are hoping that Toronto and Montreal will join us before long.

If one wishes to discover the strength of an organization he inquires into the resourcefulness, purpose and zeal of the individual members. Let us study very briefly a few of the laborers in our vineyard.

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*Read before the American Laryngological, Rhinological and Otological Society, in Montreal, on May 31, 1926.

A little girl in an educated and refined family found herself becoming increasingly deaf. She was sensitive both to outside comment and to the opinion of her family. All knew her to be somewhat hard of hearing, but by intentional deceit, by quick guesswork, by a sensitive intuition, she kept not only her teacher and her playmates but even her observing parents in ignorance of how extreme her trouble was. She progressed through school under this extreme handicap. Finally a nationally known otologist was consulted. He it was who found her not only deaf but in the very nervous state created by the successive years of petty deceit, evasive effort and fear of detection. To him she unceasingly renders tribute for curing her mind, even though the ears were beyond help. She now devotes her means, her keen and understanding mind, her energies, her life to the interests of the hard of hearing.

A missionary went to the Orient. An increasing deafness finally contributed to her giving up her life work. She learned lip-reading, and found in the teaching of this art a source of livelihood. Her buoyant optimism and her missionary zeal are now focused upon the many activities in behalf of the deafened in the Western State where she lives.

A music teacher's hearing became so impaired as to handicap her in her profession. Discouraged, she sought advice from one after another. Finally she came to a prominent member of our Society, who understood the psychology of the hard of hearing. He not only persuaded her to cease her wanderings, but he sowed the seed of interest, which bore such fruit that she is now one of the leading champions of the hard of hearing in this country.

A skillful young surgeon is almost totally deaf. He is so keen a lip-reader that many can hardly believe he does not hear. By more earnest use of the other senses he more than makes up to his patients for the loss of his ears. Much of his spare time and gay courage is freely bestowed on this work for the hard of hearing.

A prominent business man found himself shut off by his deafness. He identified himself with this movement and now devotes his full time and his money to its service. He smiles when he says that his cup of life is full and running over, and

that it is only the froth on top that he cannot have. (There is a world of truth in that.)

These are isolated cases, selected from the many hard of hearing who have gone down into the slough of despond and have been lifted out by their otologist or by some leader in their local league. They are reviewed to point out the spirit that inspires these people throughout the country in a cause peculiarly their own. Almost every otologist knows of such possibilities among his patients. They serve as a tremendous latent power.

One of the best means for forgetting one's troubles is play. Recreation thus becomes an important adjunct in the rehabilitation of the hard of hearing. It is employed similarly throughout the country. The Chicago League for the Hard of Hearing had 2,010 persons attending its social functions last year. New York reports for the past season hikes, picnics, motor bus trips, pantomimes, games, card parties, teas, suppers, dances, movie parties, special trips with the children to Central Park, the Aquarium and the Hippodrome and a big Christmas festival for all. A unique event was their theater night. The league members who in successive years had been obliged to move forward from the back to the front rows in order to hear and had finally given up the delights of all spoken drama, conceived the idea of engaging a block of the theater for one night and having the seats wired with ear phones. A good play was selected, the cooperation of the Western Electric Company secured, notices were sent to all the members and to others interested in this novel event. Not only did the deafened people enjoy themselves hugely, but so did the rest of the audience and the actors.

Many and varied are the other activities. The Boston Guild has a share in the social service work of the Massachusetts Eye and Ear Infirmary, where they understand as a hearing person cannot, the psychology of the deafened. They are led by their own salaried social worker and not only study the problems that arise but have behind them a larger body of deafened enthusiasts who will help as the need develops. Peculiar cases are referred to the Guild, where they are taken in as one of the family and are handled and cared for accord-

ing to the need of each. As a side line, the Guild members meet once a week, not to sew, but to make bandages and dressings for the infirmary patients, thus relieving to that extent the burden on the nurses at the hospital.

Many of the leagues have a weekly or monthly printed news sheet which goes to each member. Sales are conducted. Lecturers come and both entertain and instruct. The radio has proved a great delight and many of the telephones are equipped with amplifiers.

One of the most useful and important activities is that for studying and adjusting employment problems. The otologist tells his patient he has done all he can, she goes back to her work only to find that her increasing deafness prevents her continuing as a stenographer or telephone operator or teacher. Failure and isolation and despondency are the result unless someone who realizes the need takes hold. The leagues have been a remarkable help here. In some cities manufacturers and employers look on them as helpful and reliable employment agencies. Sometimes the expert at the league recommends another and congenial occupation where the deaf handicap will no longer exist. Lip-reading or an ear phone may permit a continuance of the old job under little or no difficulty. In Chicago 245 sought employment last year, of whom 176 were placed. In New York, there were 1,022 interviews with 225 seeking employment, of whom 187, or over 80 per cent, were placed. The Cleveland Association has a shop where their needy members make aprons and uniforms. Sales and fairs are used to help.

Some leagues rent a suite of rooms, others own their own homes. The Boston Guild owns its clubhouse on Commonwealth avenue, where the serving of meals and eight bedrooms accommodate out of town members or visiting friends. The membership ranges from 32 for the smallest to 755 for the largest, and the annual expenses vary proportionately. Cleveland's budget is $5,000, the Philadelphia club is $6,000, Chicago is $13,500, New York is $20,500.

Let us turn to the lip-reading activities of the leagues. Most of them hold weekly practice classes for the members. For them lip-reading teachers volunteer their services, and many

secure instruction who could not otherwise afford it. Note the activity of the Chicago League. They held four classes a week, attended during the year by 1,129 persons. They also help the deafened exservice men in their community, giving 1,196 lessons last year. In order to encourage this art and in the hope not only of increasing enthusiasm but of raising the standard, the Federation is to hold a national lip-reading tournament this June in Philadelphia. The various leagues have been practicing. The sportsmanship has been splendid and the interest keen.

I would dwell particularly on the preventive program to which the Federation is pledged. Some leagues have carried this farther than have others. There is some activity in every center. When Dr. Phillips placed Love's book on "Diseases of the Ear in School Children" into Miss Annetta W. Peck's hands, neither of them could have guessed that out of that incident would develop the educational work for the hard of hearing children in greater New York. The medical clinic part was first undertaken by Dr. Hays in his own office. It grew rapidly and finally became too big for him to handle alone with his assistants. The league is striving now to arrange for an endowment which will provide for a salaried otologist who will make of this preventive research a life work. He will have trained assistants and work through present hospital clinics, social service agencies, school boards and teachers. As a start in this movement, under Dr. Phillips' leadership, Dr. Harvey Fletcher and Dr. Edmund Prince Fowler have been working with hearing tests in the public schools. Over 5,000 children have been tested and the results tabulated this past winter. If this effort is continued, who can tell what it will mean to the next generation?

The Chicago League writes very appreciatingly of the active interest and help of their consulting otologists—Joseph C. Beck, Norval H. Pierce, Charles M. Robertson, George E. Shambaugh, Otto J. Stein and J. Gordon Wilson. To win the cooperation of such a group of men is in itself a guarantee of worth while service.

Dr. Norval H. Pierce and Dr. John Theobold have been cooperating with the league in testing the school children there.

In the past two years about 13,000 children have been carefully tested. The whisper test is employed. First, a trained assistant or teacher makes the tests and finds the doubtful cases. The doctor then tests these, examines their ears and carries out such medical or surgical measures, either himself or through the family physician or the dispensary clinics, as each individual case requires.

Tabulated results of these tests follow.

Tests on Chicago school children by Dr. John Theobold:

1924-1925.

School	No. of pupils	Selected by teachers	Mild catarrhal forms	Advanced forms
Ryerson	1,661	124	25	31
Perkins Bass	1,100	77	10	15
Foster	1,375	89	9	13
Healy	1,200	58	13	18
Tilton	1,147	150	14	20
James A. Sexton	650	87	14	14
Kinzie Branch	405	70	8	10
Total	7,538	655	93	121

Lip reading suggested—total, 20.

1925-1926.

School	No. of pupils	Selected by teachers	Mild catarrh-	Advanced forms
Fulton	1,485	164	18	13
Kershaw	700	126	11	9
Holmes	878	37	5	9
Dore	910	78	5	4
Logan	1,050	120	5	3
Total	5,023	525	44	38

A unique chapter has been written by Dr. Franklin W. Bock in Rochester. Others may have earlier conceived something of such work. Many of us have tried through various channels to help the deafened children in our schools. His appears to be the honor of having first conceived and carried through a

consistent effort to go to the schools where the children are, himself conduct the tests and treat such as required help. It has been an eighteen years' task. He is preparing a rather detailed and most interesting report of this work, which he has generously let me read and refer to here.

Starting before league work had become organized, he has built up for himself and in conjunction with the present league an agency such as is now present for the otologist in any center where our Federation workers are active. Already, in Chicago, in Cleveland, in Detroit, in New York and soon in many other centers are springing up work similar to that which this pioneer has done. His experience and this report will be serving as guides to those now entering the field. It will profit to review this work and its results.

Dr. Bock's early efforts for the hard of hearing public school child met with fairly general opposition from city officials, school boards and teachers. Finally he was permitted to try out his theories on a class of retarded children. He found that so many of these had ear troubles and was able to help so many that he gained the enthusiastic cooperation of the principal at that school. Such was the beginning. Now he is welcomed by the educators and finds himself limited only by his inability to handle all the work. His deductions from this work are both interesting and authoritative. How many of us realize that such factors as an open doorway or a noisy class across the hall will furnish enough distraction to actually make a difference in the marks of a deafened child; that one teacher can be readily understood by a group of children with impaired hearing while another cannot be followed at all; that by actual test a school situated on a noisy street with trolleys passing showed a difference of from 10 to 20 per cent in the hearing of normal children when they were tested in a room fronting on this street as against their hearing in a back room of the same building; that attention to these details and a short training of the backward children in simple attention will so help the milder forms of deafness that a child previously backward will be able to keep up in his classroom work without further help?

He feels that every child should have its eyes and ears tested on admission. If this is not possible, he would test all the chil-

dren in the school at one time and at yearly intervals. If this, too, cannot be done, he would investigate carefully all the backward and inattentive children. He discusses in detail the watch test, whisper and Whipple test, the 3 A buzzer audiometer test; the 4 A phonoaudiometer test; and tells from his experience where the danger zone is in each test and beyond what point special training is called for. In general, less than a 9 per cent loss requires investigation and medical treatment, a 9 to 12 per cent loss calls for special attention, a 12 to 15 per cent loss recommends their having lip-reading work for a longer or shorter period, as results indicate; over 15 per cent makes lip-reading essential; over 25 per cent loss calls for segregation in special classes of not over twelve children where expert trained teachers can give them detailed attention. Dr. Fletcher, at the American medical meeting last month, Dr. Newhart before this society tomorrow and Dr. Bock in his recent tests with the 4 A audiometer draw interesting conclusions as to the accuracy and speed of the different methods. He was able to test 350 children in three hours by the new 4 A audiometer method. The following table is interesting:

OLD VS. NEW METHOD FOR TESTING.

1,000 in Chicago, by old method	6 per cent deafened
2,500 in Rochester, by old method	8 per cent deafened
800 in Rochester, by new method	25 per cent deafened
Private school in Rochester, new method	2 per cent deafened

This shows, first, the accuracy of the newer methods; second, it points out dramatically the difference between the hearing in one school in a crowded poor section as against that in a wealthy private school where any immediate or remote tendency to ear trouble has been promptly attended to. We need not seek farther for proof of the need of systemic preventive measures in the public grade schools. The members of this society already know such work is worth while. They are in hearty sympathy with every effort to find any pathologic condition in the ears and energetically approve anything to remedy them. They are not quite so familiar with the actual benefit that lip-reading training can afford those cases that medical aid cannot cure. Little Elizabeth may prove this point. Dr. Bock found her two years behind her class and giving

every evidence of continuing to drop behind because of impaired hearing, the result of a bilateral chronic suppurative otitis media. Treatment controlled the discharge but did not bring back the hearing. She was most unhappy; had been very eager to accomplish and to do; found herself identified with children smaller and younger and with differing interests; gradually isolated herself from play; was passing from discouragement to despondency. She was assigned to a lip reading class. In but a short time her viewpoint changed. She could not, of course, catch up with the children of her own age, but she did keep up with the class she was then in, and actually graduated with honors. What is more, she was happy again.

A school board may approve heartily of such altruistic endeavor, but find the expense makes it impossible. We may answer this objection with very interesting figures based on the expense to the city when a child drops back a grade and has to "repeat" the half year's work.

COST OF REPEATING

In a Rochester school of 800, in a peculiarly crowded section:

349 showed 12 to 15 per cent loss of hearing in the better ear.

138 of these children were promoted.

211 of them were "repeaters," as follows:

83	repeated	once, or	83	half years
60	repeated	twice, or	120	half years
45	repeated	3 times, or	135	half years
13	repeated	4 times, or	52	half years
9	repeated	5 times, or	45	half years
1	repeated	6 times, or	6	half years
211	repeated		441	half years

Cost of repeating, at $60.00 per child, $26,460.

Children are backward for other reasons than deafness. A similar and equal group of 211 repeating children was investigated for comparison. They included the stupid and the intelligent as they happened to come. These 211 children repeated for 130 half years, as against the 441 half years that the deafened children had to take, at a cost of $7,800, as

against $26,460 for the deafened children. These figures refer, of course, to their status before any constructive work was begun or any lip-reading teaching given. It shows that a deafened child repeats over three times as much as the other average backward children. Above all, these figures point out what a tremendous expense they are if constructive work is not undertaken. Another school showed 137 hard of hearing children with 48 of them going up with their class, while 89 of them repeated a total of 173 times, at an expense (at $60.00 per child) of $10,380.

Over against such expense in money and such loss of intelligent graduates for the citizens of tomorrow, let us hear of the fourteen-year-old boy who had dropped back so far and was becoming such a problem, both at home and in the school, that teachers and parents wanted to take him out of school and put him at work. As he was only fit for unintelligent labor and gave no promise of bettering his economic status, the outlook was an unhappy one for the boy. Dr. Bock found the case to be one of deafness following measles. Nothing medical could be done to improve his hearing. He insisted that the child be given another chance and arranged for his taking lip-reading. The ending is a happy one. The boy kept up with his class, went to college, where he was an honor graduate, with earned scholarships in Harvard and at Chicago, and is now the professor of mathematics in a leading college.

Such reviews the work of the twenty-nine leagues throughout the country. It tells of the latent possibilities in the thirteen smaller hard of hearing groups that are not yet affiliated with the National Federation. Individual leagues have been emphasized in order to make the story concrete. Did time but permit, I would visit with you the other centers and appreciate yet more clearly the accomplishments of these devoted and selfsacrificing workers. To do so would, however, but repeat the story of how each center is supplementing the work of the otologist in that community; it takes the case that his skill cannot cure and makes the best of what is left; helps him find some mechanical aid, such as an ear phone, which their collection of such instruments and their practical experience facilitates; gets him into lip-reading classes, has him try his hand at dramatics or editorial work or one of the many activities that the league is carrying; takes him out of himself by play or by interesting him in the problems of those who are worse

off than he is; studies his employment problem for him and helps him to secure a job or prepare himself for one more suited to his deafness; how it makes of this social and economic burden a positive force for good in his family and in his league and in his community.

The league does more. It becomes a living, active agency to help the doctor in the prevention of deafness. It holds up his hands in his efforts to rout out this disease in its early stages; it supplies the workers and the means for testing the hearing of school children; it follows up the cases, carries on the work he has begun. Through the national organization it works toward unity of effort, which alone can successfully compete with the problem. The Federation does not labor under any false conceit; it does not for a moment think itself responsible for all this accomplishment; it cannot assume the total burden of the great promise ahead in constructive work for the hard of hearing. It does, however, think of itself as the logical national agency for unifying these efforts. Its members are more concerned than any others in the successful carrying forward of this program. Through the great number of deafened throughout the country, it will increasingly prove a powerful ally to the otologist in publicity, in financial resource, in ardent, devoted workers, in research material. We consider ourselves of inestimable value to the otologist if he will but use us.

There is another side. Without the help of the otologist, the Federation will measurably fail in its high promise. We look to him to help us in organizing new groups or in stimulating the old to higher endeavor. A little advice, a word of encouragement and cheer, occasional steering as they work their way up into constructive service for the community, and the otologist will find he has sown seed which will bear a hundred fold. As the present official leader in this movement, I come to you today to seek the individual and collective endorsement of the members of this Society. We ask your enthusiastic, devoted service. I do not think we will ask in vain.

LXXXI.

FRONTAL SINUS DISEASE; THREE UNUSUAL CONSECUTIVE CASES.

By Lee M. Hurd, M. D.,

New York.

Case No. 1.—Acute purulent infection, probably associated with mucoceles from the beginning.

December 4, 1906, boy, about 16 years of age. Severe pain and tenderness over left frontal sinus for two days. Temperature 105 degrees, pulse 135, following a chill in the morning. He has had recurrent pain in this region accompanying coryza for several years.

Examination of nose: Congested and inflamed mucosa about anterior portion of middle meatus, with some pus. Right frontal transilluminates clear, left dark; antra are clear. Enlarged tender gland at angle of jaw left.

Blood count showed 3,000,000 reds, 25,500 whites, 81.6 per cent polynuclears, hemoglobin 88 per cent; no malaria plasmodia found. Ordered hot saline douches every hour. The temperature the next day was 99 4/5 degrees at 3:00 a. m., 105 degrees at 3:30 p. m. I removed the anterior portion of middle turbinate, tried to douche frontal sinus but could only get into a large ethmoid cell. Second day temperature again reached 105 degrees, pulse 135.

I then decided to open externally via Killian route. The frontal sinus was found full of pus under pressure; lining mucosa was necrotic and was removed in toto. The sinus was large for his age, extending beyond supraorbital notch and one inch in height with deep orbital prolongation. I could find no opening into nose. A large anterior ethmoid cell seemed to have expanded and blocked the frontal orifice. This ethmoid cell had a very thin bony wall and was filled with a thick mucoid material. The anterior ethmoid cells (which were congested, but showed no pus) were removed. The wound was closed. That night temperature was 103 degrees; the next day 105 degrees, then dropped to 100 degrees, becoming normal

on the third day. Four weeks later the interior of nose was entirely healed.

November 16, 1908. I saw him again with history of progressive swelling for a period of two weeks, over central frontal region, about two inches in diameter and fluctuating; also a second swelling over the old wound of left frontal sinus, with much edema of both upper lids and also edema of the scalp back to the occiput. An incision one inch long was made through the inner part of the old scar, and about one ounce of pus evacuated. The left or previously infected sinus was filled with pus; the posterior wall was covered with dense fibrous tissue, and the interfrontal partition was necrotic and perforated; the right frontal sinus walls were covered with thick polypoid membrane, and the nasal orifice of the right sinus was situated rather posteriorly and was small.

Two weeks later, when the edema and swelling had subsided, through a double Killian incision, the floor and the balance of the interfrontal partition and all the frontal mucosa were removed, but the anterior frontal wall was preserved and the right ethmoid cells exenterated. On the left side the dense fibrous tissue completely closed off the left nasal cavity. A pure culture of long chain streptococci was obtained from the pus.

In 1912, a small movable painless elastic mass could be felt behind the nasofrontal articulation where the floors of the frontal and ethmoids had been removed. In September, 1913, he had a coryza following surf bathing; there was a feeling of fullness about right frontal, with some purulent nasal discharge; he was tender over right frontal and very tender to inner side of the right eye in ethmoid region. Suction brought nothing from the frontal region. The temperature was normal.

In June, 1921, the swelling behind bridge of nose was larger and a protrusion of right eyeball, which had been present for some months, had increased.

In September, 1922, swelling behind bridge of nose was larger, and eyeball had markedly protruded downward and outward.

In December, 1922, orbital swelling, pain, edema of lids with congested conjunctiva and proptosis occurred. Pain and swelling increased. A one inch incision was made in right

scar, evacuating two drams of very thick mucopus (staphylococcus pyogenes aureus). Four days later eyeball had receded 50 per cent; there was some diplopia.

January 9, 1923, under general anesthesia, I opened through previous double incision and found large cyst or mucocele in upper part of orbit and right frontal sinus, which had by pressure doubled the size of sinus cavity. The contents of the cyst were thick mucus, and the lining membrane very thin.

The mass previously mentioned, in the median line behind the nasal bones, proved to be another cyst. Three other small cysts behind this one and to the left were removed. Large openings were made into both sides of the nose. All of the interfrontal septum was removed with part of the nasal septum to the crista galli. On February 23, the right eye was reported normal.

As it was impossible to be sure that all cystic membrane had been removed, the Lothrop technic of drainage into the nose was done. Since 1923, he has had a thick, viscid, orange colored discharge into the nose from time to time, and although I have douched the frontal cavity many times, I have never recovered any of the cyst secretion.

Case No. 2.—Ossifying periostitis. A man, aged 43, had had trouble with nose and frontal headaches for twelve years. An external frontal and antral operation, right side, was done nine months ago, since which time he has had repeated attacks of frontal inflammation, with purulent discharge through fistula in upper lid. Reoperated a few weeks ago; no better; purulent discharge from nose, no headaches since last operation.

My examination showed pus from right frontal into nose and from fistula through scar in right eyebrow. Transilluminates dark for all sinuses. Large soft mass in region of right ethmoids. Douched pus from right frontal sinus via fistula. Antral douche showed only a few shreds. Four days later got only a few shreds on douching frontal. Fistula closed. Two days later, tender swelling right forehead, pus from frontal sinus into nose.

Operation: Opened right frontal, usual incision; anterior wall entirely removed and found this was greatly thickened with new formed bone; there was as well a thickening of posterior wall, so that the greater portion of sinus cavity was rep-

resented by a cleft not more than 2 mm. wide, except at the lower inner portion, where there was a small cavity about 5 by 10 mm.; the anterior wall was from 10 to 15 mm. thick. All this new formed and softened bone was removed. The ethmoid cells were filled with polyps and were exenterated. Antrum was opened through canine fossa and cavity found almost obliterated with fibrous tissue; he was entirely healed in eighteen days, except for some crusting in nose.

Case No. 3.—Acute panosteitis following trauma from impact with water, with probable rupture of orbital ethmoid plate.

A girl, aged 18, who had been under my observation for the previous eight years, and who at the age of 10 had an acute antrum on the right side complicating influenza and no other trouble with the nasal sinuses until she fell from an aquaplane, striking the water with considerable force; that night she had pain about the left eye, and swelling of the lids rapidly developed. When I first saw her, five days later, she had swelling of the eyelids, forehead and cheek, with congestion of the conjunctiva and pain in eye. The eyelids were so swollen she could not open the eye; she also had tenderness of the frontal sinus; temperature 102 degrees.

I immediately operated by the Killian technic; the mucous membrane of the left frontal sinus was loose and gangrenous and lifted out in toto; the interfrontal partition was red, softened and perforated, with free pus in right frontal sinus; ethmoid cells full of pus and the membrane, like the frontal, could be lifted out in toto; and the bony partitions of the ethmoids were breaking down.

The periorbita, in relation to the anterior ethmoid cells, was covered with fibrin and thickened. The posterior ethmoid cells were not affected.

I removed the anterior wall, the floor of the frontal sinus and all of the interfrontal partition, and removed the bone between the right frontal orifice and the left side (a modified Lothrop technic) and a portion of the nasal septum was removed just below the floor of the two frontals.

I also removed all the anterior ethmoid cells and explored the posterior cells and incised the periorbita through the thickened portion, but did not find pus; closed the incision with small drain at internal end. Next day there was much less

swelling of eyelids and forehead, and some pus from drain; two days later considerable pus through drain and into nose; temperature 101 degrees. Five days after operation all stitches were taken out and wound strapped with adhesive and dressings left off. Considerable pus in nose—irrigating with Dakin's solution. An external strabismus, due to paresis of the internal rectus, which had been present before the operation, had nearly disappeared on the fifteenth day. Almost no pus from the nose, but bare bone could be detected on posterior wall and bridge of frontal sinus and roof of ethmoids, and through a small fistula at lower end of incision the bony bridge seemed movable. Twenty-five days after first operation I again opened through first incision and found the bony bridge, the entire posterior wall of frontal sinus and the cribriform plate necrotic; this necrotic bone was removed in several large sequestra, revealing granulations on the dura; the wound was sutured and I depended on drainage through the nose. The sutures and dressing were removed on the second day, and on the fifth she returned home. The diplopia disappeared in a few weeks, and she has remained well a period of two and a half years, except for an acute antrum on the opposite side, six months after the operation.

LXXXII.

THE ETIOLOGY AND TREATMENT OF NERVE DEAFNESS.*

By Francis P. Emerson, M. D.,

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Boston.

1. In the theory of mechanical deafness it is difficult to understand why the loss of tone perception always takes place in that part of the scale represented by the whispered voice first, with the low notes the last to be involved. 2. In a fulminating case with the drum membrane and ossicles gone, why is the hearing so good? 3. Why do so many cases end in nerve deafness and when did it begin? 4. Why are tinnitus and vertigo such common symptoms? 5. Why is it not possible by hearing tests to distinguish perception deafness from that that follows a secretory or purulent process in a chronic case?

If we have a fulminating case of otitis media, there is great damage to the conduction apparatus and profound deafness, but after the toxemia clears up the hearing is often very good, although the conduction apparatus is badly damaged. In analogous cases, where an upper respiratory infection is followed by damage to some distant organ, we know that further trouble may result as the acute stage merges into a subacute or chronic process by repeated exacerbations of the local infection. Have we any evidence that this happens in the organ of hearing and that the original focus of infection in the lymphoid tissue may act indefinitely on the end organ as a toxic process with each acute exacerbation?

In considering the etiology of nerve deafness, it is not intended to include those cases associated with specific disease, meningitis, otosclerosis or advanced internal ear disease.

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*Read as part of a symposium at the meeting of the American Otological Society, June 3, 1926, Montreal, Canada.

In a study of the organ of hearing and the factors that modify or destroy tone perception, we have to first consider the function of its component parts, the conduction and perception apparatus.

The interpretation of the function of the conduction apparatus should be based on the accepted law of physics for the transmission of sound waves through media of different densities. On the other hand, the perception apparatus to which these sound waves are carried for registration and interpretation is a highly organized nervous mechanism, which is subject to derangement in its normal function by systemic conditions which affect the nervous apparatus as a whole—bodily fatigue, deleterious substances that circulate in the lymph and blood streams, as well as by changes in the end organ itself. Too often we look upon the loss in tone perception as though it were a mechanical problem in which we must find some gross pathology in the conduction apparatus to explain the loss in hearing, provided we were not able to demonstrate evidence of inner ear or eighth nerve involvement. Is this not an attempt to estimate functional nerve derangement according to the law of physics?

Otitis Media Secretory.—It is well recognized that following some infection in the upper respiratory tract we have a tubotympanic catarrh, and associated with such an acute process there is a loss in tone perception for the low limits and in varying degree throughout the scale. If the infection was of low virulence the resulting tubotympanic catarrh clears up and the low limits become normal. If, however, this acute process was the forerunner of a slowly progressive loss of hearing, although the low limits become normal and the tubes clear, the hearing for the whispered voice does not return to normal. Moreover, the further loss in tone perception is in that part of the scale represented by the whispered voice. This progressive loss of hearing may go on for years without the low limits being perceptibly raised, except when there is an acute exacerbation of an upper respiratory infection. In all acute infections involving the middle ear, even where the loss of hearing is so slight that the ordinary tests do not show any change, the audiometer will usually reveal lessened tone perception in that part of the scale which is not affected by

the conduction apparatus. It is not, then, until the patient is quite deaf that the infection spreads from the original focus of infection by continuity of tissue to the mouth of the tube, and this is indicated by the elevation of the low limits. Cases of secretory otitis media are characterized by tinnitus very early in the disease, and this is accentuated by each exacerbation of the focal infection. Tinnitus we know to be a symptom of labyrinthine irritation. It occurs with acute closure of the tube and increased tympanic pressure, but it also occurs later in the disease when the tube is unduly open. Tinnitus, indeed, may be an almost constant symptom, and the patient continually complains that if it were not for the noise he could hear. Some patients have a sensation of fullness and intratympanic pressure, while others complain of painful sensations when in the presence of loud noises, and others even wear cotton in the canal on account of the sensitiveness to wind and noises. Vertigo is often present, with or without disturbance of equilibrium, and, like tinnitus, is to be referred to irritation of the labyrinth. Fatigue is always accompanied by marked lowering of tone perception. Patients with all types of deafness notice that when they are tired they are apt to have a buzzing tinnitus and loss of hearing. After the primary infection, when the course of the secretory process is more subacute or chronic, the loss of tone perception is still more in that part of the scale represented by the whispered voice than in the low limits affected by obstruction in the conduction apparatus. We have here, then, a disease characterized by irregular exacerbations, with evidence of labyrinthine irritation throughout its course, with a progressive loss of tone perception in the middle register long before the low limits that are affected by the conduction apparatus are raised, and finally ending in lowered bone conduction. Cases of secretory otitis media rarely become as deaf as in the more fulminating types, but occasionally some intercurrent disease will so lower the patient's resistance that the disease progresses until there is evidence of marked nerve involvement.

Purulent Otitis Media.—In the purulent types the eustachian tube becomes involved throughout much more rapidly, and the stage of congestion and cell proliferation is followed by secondary atrophy, so that the mouth of the tube becomes tri-

angular in shape and the lumen enlarged so that the tube is too open. If the low limits are raised on account of the tube involvement, these do not change until perception for the whispered voice is nearly lost, and as the process becomes chronic the hearing test gradually approaches that seen in the secretory form, with the same tendency to develop lowered bone conduction at the same stage and finally to end in nerve deafness. In other words, there is no hearing test characteristic of any chronic middle ear disease. Neither is there any type of deafness that does not advance irregularly following each acute exacerbation of a focal infection, whether we call the process nerve deafness or the deafness that is the result of a secretory or purulent otitis media. In fact, all chronic infective processes in the middle ear with a steady loss of tone perception, that are well advanced, show a hearing test so nearly alike that no otologist could tell what tissue changes had taken place in the middle ear. In the case of a chronic purulent process there develop nerve changes more frequently than in the secretory form, whose progress may be arrested at an earlier stage. It is not uncommon for a patient to have a chronic secretory ear on one side and an old effectus ear on the other, with a hearing test nearly identical, for in all cases of chronic deafness there is a tendency for the loss of tone perception to become equal on both sides, as we would expect that it would if deafness were a gradual obtunding of tone perception.

When the infection is virulent, tone perception is not menaced as in the dry tubotympanic processes, where the infection is of low virulence and the end organ is damaged more slowly and permanently. In the purulent type there is an active and fulminating process that is destructive to the soft tissues, but here the toxemia has but a transient effect on the end organ, and tone perception is more quickly and completely restored.

Perception Deafness Without Pathology in the Conduction Apparatus.—Beside the hypertrophic and purulent types of middle ear disease there is another class that was formerly called the hyperplastic or catarrhal adhesive form, for the reason, apparently, that no pathology was found in the nasopharynx. It is evident, however, that no chronic hyperplastic process could be present in the middle ear as a primary tissue reaction, for

chronic hyperplasia means irritation, and irritation is followed by increased blood supply and cell proliferation, which must involve the lining membrane of the cavum. There must have been, then, at its inception, an exudative process, even if hyperplasia was the predominant tissue reaction throughout the disease. Nevertheless, there is a third class, characterized clinically by a slowly progressive form of deafness, coming on usually at about middle life, although cases are found at all ages. There is no history of implication of the eustachian tube, and the drum membrane is normal in color, with the light reflex present, with no indication of atrophy or hypertrophy of the soft tissues. The hearing test is often identical on both sides with normal upper and low limits, the hearing for the whispered voice is down and the Rinne positive or negative, but usually positive until the low limits begin to be elevated. The lymphoid tissue is not active and there is no history of otalgia or tube and middle ear involvement in childhood, although there is no question that in some cases the infection spreads by continuity of tissue to the eustachian tube as a late development without involvement of the tympanum, but so long as the low limits are normal the tube is not a factor in progressive deafness. It does not seem probable that any mechanical cause would equally affect both ears so that tone peception would not vary in air and bone conduction even one second. These cases the writer has called perception deafness without pathology in the conduction apparatus.

Mrs. H., age 59, was first seen by a professor of otology in one of our large universities in 1915. She gave a history of frequent sore throats, and with each infection her hearing was markedly diminished. The drum membrane was of normal luster, the light reflex was present but narrowed, and there was marked retraction. There was no atrophy or hypertrophy, the posterior fold was somewhat thickened, changes that would naturally follow long standing retraction of the drumhead. There was no history of the tubes having been involved, although at some time there must have been acute closure without exudation, to account for the marked retraction of the membrana tympanum. A diagnosis of nerve deafness was made, and the patient was advised to take up lip reading, as the progress of her case indicated that she would be very deaf

in four years. The hearing at this time was 6/25 for the whispered voice for both ears, with the Rinne and low limits normal. The patient consulted the writer within a month, and, with the history of chronic tonsillitis, which seemed to precede every additional loss of tone perception, immediate tonsillectomy was advised. This was done and the throat treated four times postoperatively. She then went to the mountains for two months, and on her return the hearing test was 20/25 in the left ear and 9/25 in the right. The throat was treated at weekly intervals for five times and the patient then discharged. She was not again examined until May of this year, an interval of seven years. She is now 70 years old, and gave a history of being confined to her residence last winter and also this winter on account of poor health. The hearing for the whispered voice was 3/25 in the right and 6/25 in the left ear, with normal upper and low limits, and a positive Rinne.

1. Mrs. J. H. 2.

May 20, 1915			Dec. 10, 1915		
R		L	R		L
6/25	W. V.	6/25	9/25	W. V.	20/25
20″/10″	Rinne	32″/15″	30″/15″	Rinne	22″/12″
	512 C^2			512 C^2	
.....	Weber	.....	.....	Weber	.....
N	U. L.	N	N	U. L.	N
32	L. L.	32	32	L. L.	32

3. Miss M. E. G. F., age 44. Duration, ten years. Diagnosis: Nerve deafness with lowered bone conduction.

R		L
2/25	W. V.	2/25
75″/15″	Rinne	40″/14″
	512 C^2	
.....	Weber	.....
N	U. L.	N
32	L. L.	32

Patient was very unstable nervously. There was pain in the right eye, and she was being treated for retinitis. After the extraction of two abscessed teeth the retinitis cleared up, as well as the nervous symptoms, and her hearing gained three feet without treatment. Previous tonsillectomy.

KEY TO HEARING TESTS.

W. V.: Whispered Voice.
Rinne: Determined by 256 C or 512 C^2.
Weber: Determined by 256 C or 512 C^2.
U. L.: Upper Limit, Monochord or Galton Whistle.
L. L.: Dench Fork.

4. Mr. J. H. L., age 43. Duration: Right, 10 years; left, 6 months. Tinnitus continuous. Diagnosis: Nerve deafness.

Two teachers from the head of their department in otology told him six years ago that he had nerve deafness and nothing could be done. Hearing test made as he was getting over an acute exacerbation. Both membrana tympani dull and lusterless. Nose: Left, chronic antrum and ethmoiditis, with the history of repeated exacerbations, which patient felt was the cause of his deafness.

January 22, 1923.

R		L
1/25	W. V.	1/2/25
9″/7″	Rinne	10″/0″
	512 C^2	
	Weber>	+
N	U. L.	N
32	L. L.	64

Note the absence of bone conduction in the left ear following an acute toxic process.

5. July 1, 1923.

R		L
3/25	W. V.	20/25
11″/8″	Rinne	24″/6″
	512 C^2	
	Weber>	+
N	U. L.	N
64	L. L.	64

Operation: Left radical antrum and ethmoid exenteration, after two months' treatment.

Wassermann negative.

Patient went eighteen months without treatment and with the hearing becoming more acute. He then had the "flu," and his hearing dropped to 3/25 in the left ear.

Mr. A., age 38. Diagnosis: Eighth nerve deafness.

April 6, 1922. Following an acute infection there was pain over the right eye. Right canal and auricle swollen. Hearing impaired. Could not retain food. In bed four days. On getting up could not walk without support and was dizzy. Tinnitus marked. May 10th, one month later, a professor of otology made a diagnosis of eighth nerve deafness. June 16th, examined by the writer. Patient complained of pressure in his ear and an unstable condition. Tinnitus like escaping steam. Slight vertigo, not influenced by position of the head. Bárány test negative.

Diagnosis: Eighth nerve deafness. Right chronic antrum with polypoid degeneration.

Operation: Right radical antrum.

October 17, 1922. Whispered voice increased to 9/25. Bone conduction unchanged.

October 25, 1922. Hearing normal and it has remained so since.

6. Mrs. W. H. M., age 56. Duration, one year (?). Head noises for years. A. D., Eff. O. M. S.; A. S., O. M. C. C.

R		L
1/25	W. V.	1/25
60″/25″	Rinne	75″/17″
	512 C^2	
.....	Weber	.....
N	U. L.	N
32	L. L.	32

Note the tendency for hearing to become equal, and also the lowered bone conduction.

7. Mr. McB., age 28. Duration, five years.

A. D., O. M. C. C.; A. S., Eff. O. M. A.

R		L
1/2/25	W. V.	1/2/25
18″/13″	Rinne	10″/14″
	512 C^2	
.....	Weber	.....
N	U. L.	N
128	L. L.	128

Different middle ear conditions but with the same effect on the end organ.

8. Mrs. J., age 31. Duration, five years. B. Eff. O. M. S.

R		L
10/25	W. V.	10/25
70″/45″	Rinne	80″/50″
	512 C^2	
+	<Weber	
N	U. L.	N
32	L. L.	32

Note the tendency for the hearing to become the same in both ears as the case progresses.

9. Miss A. R., age 51. Duration, five years. B. Nerve deafness.

April 22, 1924

R		L
5/25	W. V.	4/25
35″/16″	Rinne	40″/15″
	512 C^2	
.....	Weber	.....
N	U. L.	N
32	L. L.,	64

10. October 17, 1924

R		L
25/25	W. V.	16/25
50″/35″	Rinne	35″/16″
	512 C^2	
.....	Weber	.....
N	U. L.	N
32	L. L.	32

Following tonsillectomy and without inflation the hearing returned in the right ear.

Analysis of One Hundred Consecutive Cases.—In an analysis of the last 100 cases which consulted the writer, there were 39 bilateral cases of perception deafness, where the middle ear was normal, whose hearing was 4/25 or below; 34 were under 50 years of age. Of the same type of case, but where the hearing test was slightly above 4/25, there were 8 additional cases, making 47 out of 100 consecutive cases. Of the other cases there were four of the internal ear, one eustachian tube, two boilermaker's deafness, and 22 old effectus ears. The balance were cases of unilateral nonsuppurative deafness. An attempt was made to discover the age at which the loss of tone perception was first noticed and the cause, but as these cases are insidious in their onset, some of the patients gave very indefinite answers. Of the bilateral nonsuppurative cases, with the hearing below 4/25 for the whispered voice in 40 cases, the average age at which deafness was first observed was 41½ years. The etiology of all the different types was believed to be as follows: Otosclerosis 1, whooping cough 1, teeth 2, sinuses 2, measles 2, boilermaker's deafness 2, grippe 3, and chronic tonsillitis 22.

These figures, while no claim is made for their exactness, are significant in the fact that the age of onset was well after that at which we would expect the infectious diseases to be an active factor. They show their relation to a local focus, as these cases all date the onset of their deafness from an attack of grippe, tonsillitis or some definite infection. We know that a chronic focus in the lymphoid tissue may produce a toxin that is carried indefinitely to the end organ through the lymph channel after the barrier of the lymph nodes has been once overcome, whereas if it were discharged into the blood stream it would be carried to some organ with sufficient resistance to establish immunity. That this happens is seen from the fact that when this focus is in the tonsil the tonsillar gland on the same side is sensitive to pressure with each acute exacerbation that is accompanied by loss in tone perception. In a chronic focus like that present in a case of secretory otitis media, the exacerbation may not cause more than a transient throat irritation, and here the reaction in the gland may not be sufficient to produce pain on pressure, although the enlargement can

usually be felt. At the same time there is an increase in the tinnitus and deafness and a tendency to relapse.

It is sometimes difficult to differentiate between an advanced case of nerve deafness and otosclerosis, as the latter has no typical hearing test, and in both there may be stapes fixation and an associated tubotympanic catarrh where fibrosis or calcification of the cartilage in the annular ligament may have ankylosed the stapedial joint, as we would expect would occur from osseous deposits in otosclerosis. In a few cases the family history is about the only reliable differentiation.

Treatment.—If chronic deafness were a mechanical problem we could not expect that the removal of a focus of infection would do any good. From a practical experience of twenty years, the writer has found that if the hearing has not fallen below 6/25 for the whispered voice and the Rinne is positive, we can expect to regain some of the loss in tone perception. The important question is, "Did the deafness come on gradually or were the exacerbations fairly well marked?" The possible improvement has nothing to do with the pathology present in the middle ear, unless there is infection in the soft tissue. It is usually recommended that the eustachian tube be the first point of attack, whereas it was not a factor in 47 out of 100 consecutive cases, where the middle ear and tube showed no pathology. The problem, then, is to restore some of the lost tone perception and to prevent reinfection of the lymphoid tissue, the last problem being the more important, as chronic cases do not lose in hearing between the acute exacerbations of their focal process. The first step is to remove surgically the source of the infection and institute follow up treatment until the surrounding tissues are free from infection. Of course, we treat the eustachian tube. Inflation is of value for a short time while there is obstruction or in case the drumhead is indrawn or there is an unresolved exudate in the middle ear. Inflation is of no value as a routine treatment in chronic cases. It is poor treatment to actively treat the infection in the eustachian tube with congestion, cell proliferation and active infection in the sinuses, walls of the nares, epipharynx and glands until we have first stopped the infection here and improved the circulation in the blood and lymph channels.

There is no test that will give us definite knowledge as to

how much the end organ has been damaged. Cases whose hearing is down to 1/25 for the whispered voice will often improve, while in others we will fail. In a chronic infection, as we would expect, there may be secondary foci in other glands; the gall bladder, appendix, intestines, prostate, etc., and all such conditions must be kept in mind. The hemolytic streptococci always affect the blood cells, and many cases should be treated in connection with an internist. In a long standing infection one would expect dysfunction of the endocrine glands, but their treatment has not increased tone perception in the hands of the writer; although the metabolism has improved. Increased exygenation by a life in the open, exercise and plenty of water have given more definite results by increasing the patient's resistance. There is also much to be gained by the use of the radio and similar tone excitants used systematically to exercise the patient's tone perception for those notes not usually heard, and thus prevent loss of function from disuse. Intestinal toxemia and the regulation of the patient's habits are also of great importance.

The subject is too large to do more than lay down general principles, but the results are as gratifying as we would expect from the treatment of any chronic disease. Our responsibility in preventing these cases from becoming chronic should be realized.

CONCLUSIONS.

1. All acute middle ear infections are characterized by tissue reactions in the conduction apparatus and also by the action of the toxin on the end organ, causing tinnitus, vertigo, and often increased sensitiveness to loud sounds, wind, etc.

2. The tinnitus or sensitiveness may precede the loss in tone perception.

3. Tone perception is first lost in that part of the scale represented by the whispered voice, and the patient is quite deaf before the low limits are permanently raised, or, in other words, after the subsidence of an acute tubotympanic catarrh the patient is quite deaf before the tube is again a factor.

4. In all chronic cases of middle ear deafness the loss of tone perception tends to become the same for both ears.

5. The loss in bone conduction is common to all chronic forms of middle ear disease and is only a step in the loss of tone perception.

6. The same type of hearing test with identically the same loss of tone perception in proportion to its chronicity is seen in nerve deafness without involvement of the conduction apparatus.

7. Most cases of chronic deafness of all types will improve, if tone perception for the whispered voice is not below 6/25, if there is not lowered bone conduction.

8. All types of deafness are prone to relapse with recurring infections.

LXXXIII.

MEMBRANOUS LARYNGITIS AND TRACHEOBRONCHITIS (NONDIPHTHERITIC).

By T. R. Gittins, M. D.,

Sioux City.

The object of this paper is, first, to report a group of cases in which the early symptoms simulated the onset of laryngeal diphtheria, but in which the clinical course, especially following tracheotomy, was quite different than in this disease. On culture, these cases proved to be negative for diphtheria bacilli, and positive for some other organism, usually the streptococcus, often the staphylococcus, and occasionally the pneumococcus and influenza bacillus. Second, to give a digest of the American literature of the past twelve years pertaining to similar cases.

These cases are not reported with the thought that they are rare, but rather with the feeling that similar ones quite frequently occur, and perhaps some are treated and reported as diphtheria. Perhaps no cultural study is made in some instances, and it may be that even in the event of a negative laboratory report for diphtheria bacilli some cases are treated with antitoxin and reported as diphtheria because of the clinical picture so commonly associated with this disease. It is also a possibility that a few diphtheria bacilli found in cultures may lead to a diagnosis of diphtheria, when the predominating organisms may be streptococci or staphylococci, in pure or mixed culture. It is common knowledge, I think, that diphtheria bacilli may be reported in cultures from apparently normal throats in at least a small percentage of cases examined. It is likely, then, that at times where the laboratory reports only a few diphtheria bacilli, and numerous other organisms, the presence of the former may be only incidental, and may have no direct bearing on the symptoms or clinical course. I have no doubt every member of this society is familiar with the type of case considered in this paper, but it is hoped that

the discussion may bring out some points of interest and value as to incidence and treatment.

The use of the word "membranous" in the title of this paper is not entirely accurate, and may be open to question, because in some of the cases considered no real membrane was evident on direct examination of the larynx. However, in most of the cases, a membrane, at or least a pseudomembrane, was present in the larynx below the true cords and in the trachea. The edema of the mucous membrane over the arytenoids and false cords sometimes concealed a thin membrane in the lower part of the larynx. For the purpose of this paper, it might be best to consider the term "membranous laryngitis" as a clinical entity rather than a pathologic one, so as to better discuss it in relation to the commonly known "membranous croup" of diphtheritic origin.

The subject matter of this paper is based upon the experience with fourteen cases which have occurred in the private practice of my associate, Dr. J. B. Naftzger, and myself during the past six years. In eleven of these case reports, culture from the larynx or trachea, or both, was positive for streptococci or staphylococci in pure or mixed culture, with no diphtheria bacilli; in three of the cases a few diphtheria bacilli were found, but the predominating organisms were either streptococci or staphylococci. The ages of the patients ranged from one year to ten years, with eight two years or under. Tracheotomy was done in ten of the fourteen cases, while four were of a milder type, did not need tracheotomy, and recovered without sequelæ. Intubation was tried in one or two of the earlier cases, but proved very unsatisfactory and has not been done since. During the same six years, twelve cases of true laryngeal diphtheria were encountered—that is—diphtheria bacilli were the predominating organisms found in culture, and the findings at tracheotomy and subsequently were typical of this disease. Eleven of these twelve patients had tracheotomy.

It may be of interest to note here that since 1923 we have treated but one case of true laryngeal diphtheria, while in that year alone we encountered five, all severe enough to need tracheotomy. On the other hand, since 1923, eight cases of laryngitis or tracheobronchitis of nondiphtheritic origin have

come under our care, four of which have had tracheotomy. It is likely that the widespread use of toxin antitoxin has played a prominent part in this reduction of diphtheria incidence in our practice, though accident may have played a part in affecting such statistics where such a small number of cases were considered. No cases are included in this report where the tonsils, pharynx or nasopharynx were involved, though several of this type have also had a laryngitis and tracheobronchitis similar to that described here.

SYMPTOMS AND CLINICAL COURSE.

In order to describe the clinical picture encountered in these nondiphtheritic infections, the first case, occurring in January, 1920, in which we recognized this condition as distinct from laryngeal diphtheria, will be reported briefly. It is very likely that similar cases had been encountered previous to this time, but their true nature had not been recognized.

This patient, a child of 19 months, was seen in the country, after three days of gradually increasing dyspnea, croupy cry and cough and some spells of cyanosis. Examination revealed tonsils and pharynx negative, with edema over arytenoids and false cords, and a thin gray membrane lining the larynx. Tracheotomy was done, and in the trachea was evident a similar gray membrane with thick brownish secretion. Semisolid masses of this same material were coughed out through the tracheal wound. Diphtheria antitoxin given. Dyspnea was relieved for several hours, but gradually returned, accompanied by cyanosis, even though the tracheal canula was kept open. At times some of the sticky brown substance was coughed out of the tube, with some relief of difficult breathing. By the end of the first twenty-four hours after tracheotomy, dyspnea and cyanosis were marked, the pulse was weak and thready, and the temperature had risen to 106. Deficient breath sounds were evident by auscultation over the lungs, but there seemed to be no free discharge in the trachea. By this time the laboratory had reported streptococci predominating, some staphylococci and no diphtheria bacilli. Because of the continued labored breathing and apparent air hunger, a bronchoscope was passed and plugs of the thick brown tenacious material were removed from the openings of the large bronchi. There was some relief

of dyspnea and cyanosis after this procedure, but these symptoms soon became evident again; the pulse became weak and thready, and death occurred thirty hours after tracheotomy. At autopsy, the larynx, trachea and large bronchi were found to be lined by a thin gray membrane. There was a scanty, sticky discharge in the trachea and large bronchi. In the smaller bronchi and bronchioles the brown semisolid discharge practically blocked the lumina, accompanied by an edema of the mucous membrane. This postmortem finding helped to confirm the belief held before death, that the serious symptoms were probably due to mechanical obstruction rather than toxemia.

The laboratory reported that in portions of the membrane from the trachea the predominating organisms were streptococci with some staphylococci, but no diphtheria bacilli. There were similar findings in the culture from the free tracheal discharge. The semisolid masses of tenacious material from the smaller bronchi were made up of fibrin, leucocytes, some epithelial cells and some organisms, apparently streptococci.

The clinical courses of the other cases reported here were quite similar in that there was the tendency for serious dyspnea and cyanosis to return at intervals of a few hours for days after tracheotomy, though the tracheal canula was kept open continuously. The early symptoms, previous to tracheotomy, that is, dyspnea, croupy cry and cough, laryngeal stridor, etc., simulated the onset of laryngeal diphtheria, and they varied in severity and rapidity of development, just as they do in this disease. The most characteristic finding throughout was the thick tenacious brown secretion in the trachea, which, if not removed often, had the tendency to form in semisolid tenacious plugs and thus obstruct the air passages. In some instances there was an entire lack of cough reflex and practically no liquid discharge, but rather the formation of a sticky coating over the free end of the tracheotomy tube, on the tracheal mucosa and in the bronchi. A more rapid and serious clinical course was the rule where this condition was present. More favorable results were obtained when cough was present and when the secretion in the trachea remained liquid. Suction, by means of a catheter through the canula, was quite satisfactory in removing this liquid discharge, with often quick relief

of dyspnea and cyanosis. One patient, ten years of age, with each recurrence of difficult breathing, was able to keep the trachea clear by coughing quantities of this sticky brownish secretion through the canula. Suction was not used in this case, because the frequent spells of coughing served the same purpose in removing the mechanical obstruction to breathing. Recovery followed in eight days.

As would be expected, infants presented the more serious problem. One child of sixteen months recovered after three days and nights of attacks of dyspnea and cyanosis, occurring every two or three hours. One of our associates, Dr. Thien, remained with this patient for three days and nights, using the suction catheter through the canula whenever difficult breathing was evident. Cough was stimulated and the discharge made more liquid by dropping into the canula, previous to use of suction catheter, small amounts of adrenalin, one to ten thousand. During the coughing spells brown mucopurulent material came from the tube, and occasionally some semisolid plugs of the same material were extruded. It was found that keeping the tracheotomy tube open and repeatedly changing the inner tube had practically no effect in relieving the difficult breathing. The tracheotomy tube was removed on the sixth day, with no return of serious dyspnea or cyanosis, and the patient made a complete recovery.

The bronchoscope was used to remove some of these semisolid plugs from the trachea and openings of the large bronchi in the earlier cases, but in the last few years, where suction has been used early and often, in conjunction with adrenalin, it has not been necessary to resort to bronchoscopy. In our earlier cases we felt that the serious nature of the dyspnea and cyanosis, with the failing pulse and rise in temperature, was due to the systemic effect of the streptococcus infection. In the later cases, however, we have been led to believe that these serious symptoms were mainly due to mechanical obstruction in the trachea and large and small bronchi, and not necessarily to the virulence of the infecting organisms. Often cyanosis would be pronounced, even when the tracheal canula was open and clean, and there was no evidence of liquid discharge in the trachea. Obstruction low down in the air passages seemed likely, as auscultation over the lungs revealed deficient breath

sounds. Relief of cyanosis and dyspnea, and improvement in general condition, either by use of adrenalin and the suction catheter, or the bronchoscope, adds weight to the theory that mechanical obstruction rather than toxemia was the main factor. In the first case reported here, in which cyanosis preceded death, even though the tracheal canula, the trachea itself and the large bronchi were open, postmortem proved that the smaller bronchi and bronchioles were practically blocked by the characteristic semisolid sticky substance, with edema of the mucous membrane.

As a rule, we have found that the tracheal canula has had to remain in place for a considerably longer time than is necessary in true diphtheria, because of this tendency for formation of thick discharge and the return of difficult breathing. It might be best to mention here that in every case large doses of diphtheria antitoxin were given early, without waiting for the culture report.

BACTERIOLOGY.

In each of the fourteen cases considered here, direct culture was taken from the larynx at the time of the first examination with the aid of a Jackson laryngoscope, and, where tracheotomy was done, cultures were taken from the tracheal discharge and from any membrane lining the air passages. Loeffler's blood serum culture media was used, and several tubes were inoculated in every case. In most of the cases considered here, a detailed study of the type of streptococcus or staphylococcus present was not made, probably because the main object in the laboratory was to eliminate diphtheria. Where more detailed study was made, the streptococcus hemolyticus was found to be the main offender. No report came to us from the laboratory in which the staphylococcus was given as the predominating organism, though it was often named as present. A detailed cultural study of the organisms found in one case, a child of twenty months, is of special interest, because the same type of streptococci was isolated from the larynx of the mother of this child. She had been suffering from an acute laryngitis of a mild type, with some hoarseness, cough and fever, for three days before the child became ill with dyspnea, croupy cry and cough. Through the courtesy of Dr. Allan C. Starry,

director of the laboratory, St. Joseph's Hospital, in our city, I submit the following report:

Patient: Oral B., age 20 months.

Diagnosis: Membranous laryngitis.

Cultures: Taken from larynx on Loeffler's blood serum media.

"Plate cultures on blood agar showed both staphylococci and streptococci. The staphylococcus colonies were not numerous, while the streptococcus colonies were many. The staphylococcus colonies showed a more luxuriant growth than the streptococcus. After 36 hours' incubation, large round white colonies were noted. Some hemolysis also was present. When transferred to plain agar slants the organisms grew readily, and large white colonies were noted in 12 hours. Bouillon cultures grew readily. Smears from all cultures showed rather small gram positive cocci, arranged in masses and clumps.

The streptococci were hemolytic, of the Beta type. On the blood agar plates small grayish colonies occurred in 36 hours with a rather large zone of uniform, complete hemolysis about each colony. No green color was noted in any of the colonies. Transplants from these colonies on plain agar slants showed no growth after 48 hours' incubation. Bouillon to which one part of defibrinated sterile human blood was added showed a growth in 24 hours. Glucose was fermented but insulin was not. When six parts of a suspension of a serum bouillon culture was added to one part of sterile ox bile and incubated at 37 degrees for one hour, clearing did not occur. The organisms were gram positive, and preparations from serum bouillon showed moderately long chains. No diphtheria bacilli present.

"Culture from the mother's throat showed the same type of hemolytic streptococci described above and no diphtheria bacilli."

In a personal communication, Dr. L. W. Dean reports interesting laboratory findings in a case of laryngitis simulating diphtheria. After tracheotomy the bronchi and bronchioles persisted in filling with dark brown casts, which were removed bronchoscopically several times, but patient eventually died. The organism morphologically resembled a diphtheria bacillus, but culturally it proved to be a pleomorphic streptococcus.

Guinea pigs used for virulence tests died, whether or not they were protected by antitoxin. The same pleomorphic streptococcus was isolated in cultures from the pigs.

TREATMENT.

Nothing new or original is claimed for the treatment that has been instituted in the cases reported here. Again, no new disease has been described, but rather an old and recognized condition has been encountered, frequently enough in our experience to warrant more careful study of incidence and treatment. Our efforts have been rewarded by a lower mortality rate since we have centered our attention after tracheotomy, early and repeatedly, on the mechanical removal of secretions or semisolid masses from the tracheal canula, the trachea itself and the bronchi. Tracheotomy, rather than intubation, we feel has played an important part. The early removal of liquid discharge has probably, at times, prevented the formation of more solid deposits, thus giving relief of dyspnea, with a minimum of surgical shock to the patient. In those instances where there seemed to be a decided lack of liquid discharge and a dryness of the tissues, accompanied by evidence of mechanical obstruction to breathing below the tracheal canula, measures which helped to liquefy the scanty discharge and allow of its removal by suction played a prominent part in determining the outcome. In this relation adrenalin, one to ten thousand, in two to four minim amounts, dropped into the tracheal canula, seemed of value in making the discharge thinner and stimulating cough reflex. It was found that after the instillation of adrenalin the secretions could better be removed by cough or the suction catheter. We offer no explanation for the action of the adrenalin. It was used empirically, and some other substances may serve the purpose equally well. In the treatment of all the cases reported here, the well known measures, such as croup tent, steam kettle, syrup of ferrous iodid, ipecac, etc., were used, as well as other measures directed to improvement of the general condition. Each case was given large doses of diphtheria antitoxin without waiting for the culture report. In two or three cases the bronchoscope was used for the removal of the semisolid masses. The use of the bronchoscope following

tracheotomy takes the same place as an emergency measure, as the insertion of the tracheal canula does earlier in the disease. In our later cases we have felt that the bronchoscope has not been needed, mainly because other measures were used early and often to soften semisolid masses or to remove the discharge while it was still liquid.

RESULTS.

Fourteen cases of laryngitis and tracheobronchitis, nondiphtheritic in origin, are reported. Four of these fourteen were of a mild type, did not need tracheotomy, and all recovered. Of the ten cases where tracheotomy was necessary, four recovered and six died. Thus, of the entire group, there were eight recoveries and six deaths. Considering only the ten severe cases wherein tracheotomy was necessary, our records show that the first three cases, treated in 1920 and 1921, were fatal, while of the seven handled from 1922 to the present time four recovered and three died. In one of these latter fatalities the tracheobronchial condition was complicated by lung abscess and tuberculous mediastinal glands, spleen and liver. Our lower mortality rate in latter years has been due, we feel, almost entirely to the early and continuous efforts to relieve mechanical obstruction in the air passages below the tracheotomy canula. During the same six years that these fourteen cases have occurred we have encountered twelve cases, similar in onset, but in which the diphtheria bacillus was the predominating organism, and the clinical course subsequent to tracheotomy was quite different. Eleven of these twelve had a tracheotomy. Of the eleven, six recovered and five died.

INCIDENCE, REFERENCE TO LITERATURE AND PERSONAL COMMUNICATIONS.

From a review of the literature in American journals since 1914, the following references to conditions similar to those considered in this paper are taken:

McNab,[1] in 1915, reports his experience with an infant who became suddenly ill with dyspnea. Examination revealed a thick, yellow, dirty, tenacious membrane in the trachea. Culture revealed pure streptococci; no diphtheria bacilli. Recovery without tracheotomy.

Lewis[2] (Epidemiologist, Board of Health, New Haven, Conn.), in 1918, in an article on "Membranous Croup" contends that this condition is generally misunderstood as diphtheria, when in many instances it is not. Streptococcus is often the offending organism. Fatalities, he believes, often come from pinning faith on antitoxin and waiting too long before beginning other treatment. He suggests the elimination of "croup" or "membranous croup" as misleading, and the use of "laryngitis." Again, in the same journal, this author has an article on "Streptococcal Infection Simulating Diphtheria." He describes a child of three with laryngeal stenosis, intubated and sent to the hospital as diphtheria. A pure culture of streptococci was obtained. Other members of the family with purulent discharge from noses were also streptococcus carriers. He goes on to say that such a condition may exactly simulate diphtheria. His first experience with this as a new condition was in 1915. During 1916, of 164 cases reported or suspected, 61 were clinically diphtheria; the diagnosis was confirmed bacteriologically in 52 instances. In the remainder practically one-half were definitely streptococcal clinically, culturally and by demonstration of the carrier. In the remainder the proof was less complete, owing to the absence either of cultural evidence or of a carrier.

Gardner,[3] in 1918, published an article entitled "Three Cases of Infection of the Upper Respiratory Tract with Staphylococcus Pyogenes Aureus, Presenting the Symptoms Complex of Acidosis." He describes three children with a diagnosis of acidosis in which the larynx was examined because of stridor and dyspnea. There was a thin gray membrane in the larynx and a thick viscid purulent material in the trachea in each instance. Bronchopneumonia was present. Culture revealed staphylococcus pyogenes aureus and no diphtheria bacilli. All three patients died. It is this author's opinion that the acidosis was a result of this laryngotracheal infection.

Jackson,[4] in 1921, under the heading of "Croupy Cough and Dyspnea Simulating Diphtheria Due to Infective Tracheobronchitis," reports a child of two years with chills, fever and croupy cry. Antitoxin was given. Culture report was negative for diphtheria. There was subglottic swelling, no membrane, but moss agate pus in the trachea. Dr. Jackson men-

tioned that such a condition was epidemic in Philadelphia at the time.

Purcell,[5] also in 1921, wrote under this heading, "Membranous Obstruction of the Bronchi, Clinically Diphtheria. Repeated Removals with Bronchoscope. Recovery." He describes a child of four suffering from dyspnea and cough. Tracheotomy was done and antitoxin given. Dyspnea continued. Bronchoscope was passed and membrane was removed from each bronchus. There was immediate relief from dyspnea. Bronchoscopy was done several times to relieve dyspnea, with good results. More antitoxin was given. Patient recovered. No laboratory report was made, so that it is not known whether this was diphtheria or not.

Clerf,[6] in April of 1924, reports a very unusual case, which does not strictly belong in our present discussion, because the condition followed removal of a foreign body. However, the seventeen bronchoscopies which followed with removal of masses of secretion and relief of dyspnea indicate that he was dealing with a very similar condition to that encountered in the cases we are considering.

Baum,[7] in September, 1924, gives his experience with four cases of "Laryngo-Tracheo-Bronchitis." All of these cases began with laryngitis and required tracheotomy. All showed definite inflammatory changes in the larynx, trachea and bronchi. Three of the cases died of bronchial obstruction, the only recovery being a foreign body (popcorn) case. The characteristic finding in all cases was the formation of a thick, sticky secretion, scanty in amount, and having a tendency to dry in hard masses in the tracheotomy tube and in the bronchi. There was a decided absence of cough and a very marked dryness of the mucosa. Auscultation demonstrated obstruction of the larger tubes, which disappeared after the removal of the plugs by bronchoscopy. In the first case, streptococcus hemolyticus was isolated from the secretions. The plugs of secretion proved to consist of fibrin, leucocytes, red blood cells and epithelial cells. A gram positive streptococcus was present in the secretions from one of the cases. In the other two patients, the organism was in doubt.

Lynch,[8] in October, 1924, describes a condition, "Staphylococcus Laryngobronchitis." He gives his experience with a

little girl with hoarseness, aphonia and croup. Twenty thousand units of antitoxin were given. The next morning 50,000 units more. There was no pathology in the pharynx, no diphtheria bacilli in culture. There was increasing distress and tracheal tug. Tracheotomy was done. Large pieces of exudate coughed out of canula. Trachea covered with exudate not resembling diphtheria. Cultures taken. Efforts made to increase tracheobronchial secretion. Exudate softened, and was gradually cast off in a period of ten days. Bronchoscopy on second day through tracheotomy wound revealed exudate extended just beyond bifurcation. Bronchi below clear and free. Fourteen cultures through tracheotomy wound were positive for staphylococcus albus, in almost pure culture. There was fibrin, dead epithelial cells, a few leucocytes and bacteria in the exudate. Recovery was slow in contrast to diphtheria. The author mentions that this is an old disease revived. He saw five cases in one month. A detailed pathologic report is given. In discussing the treatment, the author mentions that antitoxin is useless, and measures inhibiting gland secretion are contraindicated. Warm moist air of even temperature, free purgation of tracheobronchial tree with such drugs as ipecac and iodids. He suggests that decanulation should not be attempted until absorption of exudate is complete, and intubation is not justifiable. All five of his cases recovered, but required from four to nine weeks to decanulate. The disease was practically afebrile, apparently nontoxic, except locally, and was without sequelæ. In all five cases staphyloccocus albus predominated, and in four it was present in pure culture.

Dixon,[9] in January, 1925, reports the case of a child of seventeen months, with difficult breathing. Sixty thousand units of antitoxin were given, with no relief from the air hunger. Tracheotomy was performed. Culture from the larynx revealed streptococci and staphylococci, with no diphtheria bacilli. Patient recovered. The details of treatment were not given.

Strachan,[10] in July of 1925, under the heading of "Acute Septic Tracheitis," reports three cases, all fatal, and all were autopsied. They were healthy, robust children. Symptoms began suddenly with dyspnea and hoarseness. All were thought to be diphtheria. Tracheotomy helped, but intubation was use-

less. Patients lived three days from onset. The pathology began below the vocal cords, the larynx and trachea being lined with greenish gray exudate. During the course of the disease the tracheotomy tube stopped up easily. The dyspnea was relieved some by suction. At postmortem there were found varying degrees of superficial ulceration of tracheal mucosa. Firm reddish black mass partially occluded the bronchus in one case. Other bronchi were almost filled with tenacious yellowish green exudate. Cultures from larynx and trachea revealed streptococcus hemolyticus, staphylococcus and bacillus influenza. The author suggests tracheotomy and constant supervision of the tube to maintain free airway by suction.

During the year 1925 Lewis[11] (Epidemiologist, Board of Health, New Haven, Conn.), has published three articles, and through his courtesy, I have received a personal communication and reprints of these articles just recently. Under the title, "Researches in Public Health" (11A), while discussing factors in epidemogenesis, the author makes this statement: "In 1923, four of the five deaths from scarlet fever occurred in four-year-old males, all dying from septicemia, following a membranous laryngotracheitis, streptococcal in origin, and all the cases occurring in widely separated districts without anything in common for their source of infection. The streptococcal complication can be accounted for as a part of a widespread grippe, killing three-fourths of the total year's diphtheria deaths in one month alone." Another article, "Control of Morbidity and Mortality of Diphtheria" (11B), appeared in August, 1925, from which the following statement is taken: "Our experience was that clinical laryngeal diphtheria of early childhood, during the early year following epidemic measles of the previous year, was of the first order in this ensuing increased diphtheria mortality. To have, as was recently the experience of more than one city, an unusual epidemic of diphtheria with unusually high mortality, where it was the experience that deaths occurred irrespective of early and sufficiency of antitoxin, sidetracked the issues when the only explanation was that the experience bore some relation to the influenza epidemic preceding." In November, 1925, this author writes again on "The Morbidity and Mortality of Diphtheria" (11C). His experience has led him to believe that the dominant factor

in the morbidity of diphtheria is, in the main, the "cyclic epidemicity" of measles. He goes on to prove by statistics that the mortality of diphtheria is increased during the year following epidemic measles. During 1923, it was his experience that widespread streptococcal sore throat simulated diphtheria, and though cultures of contacts and patient were negative, and early large doses of antitoxin were given, five of the seven deaths recorded for the latter part of 1923 were of this type. The last statement in this article is, I feel, very important, and it is quoted as follows: "When cultures are returning, not as negative for diphtheria, but positive for the predominant organism or organisms, I believe the as yet hidden factor in a part of the excessive varying mortality from diphtheria will be solved."

Feeling that some information concerning laryngotracheobronchitis of nondiphtheritic origin might be obtained from those doing public health work, I interviewed Mr. W. D. Hayes, Commissioner of Public Health in our city. Through his courtesy, I have personal communications from the Commissioners of Public Health in ten of our large cities. The majority of these replies were noncommittal. Several felt that wrong diagnoses clinically were common, but, of course, it was the bacteriologic diagnosis that they were familiar with. It was the opinion of most of them that reliable statistical information of errors in diagnosis was impossible to obtain. From the Commissioner in one of our three largest cities, a detailed reply was received, which gives quite definite information. He mentions that during measles or influenza outbreaks, from 10 to 20 per cent of supposed cases of laryngeal diphtheria show no exudate in the larynx or trachea, and culture rarely shows any diphtheria bacilli. He goes on to say that at times they have septic laryngitis cases, generally considered as diphtheria, which are due to streptococci alone. Statistics in his city show that 3 per cent of children there have diphtherialike bacilli, which the laboratory calls diphtheria bacilli. Therefore, in case of culture for tonsillitis or laryngitis, 3 per cent are sure to show diphtheria bacilli, though these organisms may play no part in the disease under investigation. Many of these children are Schick negative. It is his experience that the greater tendency is to call cases which

are not diphtheria, diphtheria, rather than the opposite. It is evident from these communications that those in charge of public health work in our larger cities feel that possibly a considerable number of cases of laryngotracheitis of nondiphtheritic origin are diagnosed clinically as diphtheria, but bacteriologically there is a very small percentage of error.

An attempt was made to learn from other otolaryngologists in our own city and geographic locality of their experiences with cases similar to those encountered by us. Four men from our own city replied, reporting a total of eight cases of a similar nature, especially as to negative diphtheria report and the formation of the thick, sticky secretions in the air passages. From the surrounding territory, including Iowa, part of Nebraska and North and South Dakota, eleven replies were received. Three included reports of a total of five cases, with a similar clinical course and cultural report, but the surprising thing was that eight offices reported no experience whatsoever with this type of laryngitis or tracheobronchitis. These personal communications have added emphasis to our contention that these nondiphtheritic infections are essentially of a very serious nature, especially if antitoxin is relied upon and other more appropriate treatment is neglected.

SUMMARY.

1. Symptoms.—Fourteen cases of laryngitis and tracheobronchitis, nondiphtheritic in origin, are reported. The early symptoms simulated the onset of laryngeal diphtheria, but following tracheotomy and administration of antitoxin, there was a tendency for thick, tenacious secretions to form in the air passages, and to bring on at times serious dyspnea and cyanosis unless removed by mechanical means. Four of the fourteen cases were of a mild type, did not need canulation, and recovered without sequelæ.

2. Bacteriology.—In eleven of the cases the laboratory report was negative for diphtheria bacilli, and positive for streptococci or staphylococci in pure or mixed culture. In three instances a few diphtheria bacilli were reported, but streptococci were found as the predominating organisms. These latter cases are included because the clinical course in each was very similar to that encountered where no diphtheria bacilli

were reported. Streptococci were reported from the laboratory as predominating in all cases, though staphylococci were practically always named as present. Detailed report of the type of streptococcus was obtained in only a few cases, but in these the streptococcus hemolyticus was the main offender. In one instance contact infection was suggested by the report of the streptococcus hemolyticus of the Beta type in culture from the patient, and the mother, who was also suffering with a laryngitis.

3. Treatment.—Tracheotomy was found to be essential in the severe cases; intubation proved unsatisfactory. The use of the suction catheter through the tracheal canula, early and often, supplemented by instillation of adrenalin, proved most satisfactory in removing the sticky secretions from the air passages. The bronchoscope was of value as an emergency measure to remove the semsiolid masses from the trachea and bronchi when suction failed to relieve the dyspnea. Cough incited by use of a feather or pipe cleaner through the canula, or the introduction of adrenalin, proved of value at times in helping to rid the trachea and bronchi of the thick secretions. Diphtheria antitoxin was apparently of no value.

4. Results.—Of the fourteen nondiphtheritic cases treated, ten had tracheotomy. Of these ten, four recovered and six died. The four which were not canulized recovered. Thus, considering the entire group, eight recovered and six died. It is our opinion that the fatalities were due mainly to the mechanical obstruction of the trachea, bronchi and bronchioles by the secretions rather than to the severity of the infection.

5. Incidence.—In our practice fourteen nondiphtheritic cases have been encountered in the past six years. During this same time we have treated twelve cases of true laryngeal diphtheria. Since 1923, only one case of laryngeal diphtheria has come under our care, while there have been eight of the nondiphtheritic type.

From a partial review of the literature and from personal communications, evidence is at hand that these nondiphtheritic infections have been recognized and reported for many years, though it seems very likely that a considerable number of similar cases have been treated as diphtheria, with their true nature unrecognized.

6. It seems that the recognition of such conditions simulating laryngeal diphtheria is of some importance clinically and from the standpoint of epidemiology. Clinically, if such cases as are described here are treated as diphtheria and antitoxin is relied upon, other more appropriate treatment may be delayed or neglected entirely, and the result in some instances may be a fatality which might have been avoided. From the standpoint of epidemiology, the statistics as to the prevalence of laryngeal diphtheria, and its mortality rate; the importance of the Schick test; the efficacy of toxin antitoxin as a preventive; and of antitoxin as a curative agent, may be affected in a small way at least.

INDIVIDUAL CASE REPORTS.

Charles A., age 16 months. March 6, 1924. Past history: General health has been good. Has had whooping cough. No other illness.

Present history: Patient recovering from measles. Difficult breathing, croupy cough and cry have been present for eight hours. Symptoms became quite rapidly worse, with some cyanosis during hour previous to examination.

Examination: Rather severe dyspnea, tracheal tug, retraction of intercostal muscles, some cyanosis. Rapid, weak pulse. Tonsils and pharynx negative. Thin gray membrane over arytenoids, true and false cords. A portion of membrane removed with cotton swab for culture. No bleeding of mucosa. Temperature 101.4.

Progress: Tracheal canula inserted. Local anesthetic. Breathing improved rapidly. Much thick brownish secretion in the trachea. Cultures taken from tracheal discharge and membrane. Diphtheria antitoxin given. During the next twenty-four hours dyspnea and cyanosis returned at frequent intervals. These symptoms relieved by cleaning tracheal canula and removing the secretions from the trachea with suction catheter.

Culture report: Streptococcus hemolyticus predominating. Some staphylococci. No diphtheria bacilli.

At each recurrence of difficult breathing four minims of 1 to 10,000 adrenalin solution dropped into canula. Immedi-

ately after adrenalin was instilled, cough resulted, expelling thick brownish secretions and occasionally some firm plugs from the canula. Suction used each time after adrenalin. Temperature varied from 100 to 102. Syrup of ferrous iodid internally, fluids forced by mouth, saline and brandy per rectum. On an average of every two or three hours for three days and nights above treatment of adrenalin and suction was used, indications being return of dyspnea and cyanosis. By the fourth day following tracheotomy, breathing was much improved, general condition good, small amount of secretion being removed from the trachea.

March 11, 1924. Sixth day after tracheotomy, canula removed.

March 13, 1924. Gradual improvement in general condition. Some cough, tracheal wound healed. Temperature 99, pulse 140, respirations 28. Patient developed double otitis media, but no return of difficult breathing, and gradual improvement in general condition.

March 26, 1924. Dismissed from hospital. Tracheal wound healed. Breathing normal. Temperature normal. Complete recovery.

REMARKS.

1. Early clinical symptoms and appearance of membrane in larynx simulated diphtheria.

2. Dyspnea and cyanosis occurred at intervals for three days and nights after canulation and was relieved each time by introduction of adrenalin and suction catheter through tracheal canula, with removal of thick brownish secretions. Some plugs of tenacious material coughed through canula after use of adrenalin.

3. Dyspnea and cyanosis not affected by cleansing tracheal canula.

4. Culture report: Streptococcus hemolyticus predominating. Some staphylococci. No diphtheria bacilli.

5. Recovery without sequelæ.

No. 2.—Lucille K., age, one year. February 2, 1925.

Present history: Difficult breathing with hoarse cry and rapid respiration for six days. Some cough and fever. No cyanosis. No other members of family ill.

Examination: Well nourished baby. Respirations rapid and labored. Hoarse cry. No cyanosis. Tonsils large and chronically infected. Fluoroscopy and X-ray of air passages negative for presence of foreign body. Larynx shows some thick mucopus over the vocal cords. Cords edematous and red. Gray membrane forming a cast of larynx below cords. Cultures taken. Twenty thousand units of diphtheria antitoxin given. Temperature 102, pulse 140, respirations 40.

Progress: February 3, 1925. During past 24 hours dyspnea present. No cyanosis. Early this morning respiration became more labored rather suddenly, and cyanosis appeared. Tracheotomy done. Thick mucopurulent material in the trachea. No membrane evident. Some of this same material coughed from tube. Rapid improvement in breathing and color. Temperature 105. Frothy mucus removed from the trachea by suction catheter.

Laboratory report: Streptococci and staphylococci predominating. A few diphtheria bacilli.

February 4, 1925. During the night respirations became rapid. Nurse unable to get inner tube in place if left out more than a few minutes, because outer tube would become partially filled with a brown, sticky substance. Inner tube could be inserted with difficulty and came out with the free end tightly plugged with thick, brown, viscid material. At times patient coughed plugs of the same material through the canula. After half an hour, adrenalin, 1 to 10,000, three drops at a time, was used in the tracheal canula, followed by the suction catheter. Breathing much improved after these treatments. Mucus seemed much thinner after adrenalin treatments were begun and was more easily removed with suction. There was practically no tendency for formation of the thick, brownish plugs. Temperature, 105.

February 5, 1925. Dyspnea very much relieved. No cyanosis. General condition improved rapidly. Repeated use of adrenalin and suction catheter has kept the air passages quite free. There has been practically no tendency for the tracheal canula to become closed with secretions. Patient taking feedings well. Coughing some brownish mucopus through the canula.

February 6, 1925. Temperature, 103. General condition improved. Good color. Breathing well most of the time. A few spells of cough and dyspnea which were relieved quickly with the suction catheter.

February 9, 1925. Tube removed. Breathes some through larynx. Some mucus coughed out of tracheal wound. General condition good.

February 14, 1925. Has been gradual improvement in general condition. Tracheal wound practically healed. Breathing quietly. Cultures from larynx show streptococci and staphylococci and no diphtheria bacilli.

February 18, 1925. Dismissed in good condition with apparently complete recovery.

REMARKS.

1. Onset simulated laryngeal diphtheria, but clinical course following tracheotomy was typical of that found in nondiphtheritic tracheobronchitis.

2. A few diphtheria bacilli were reported in cultures from the larynx, but streptococci and staphylococci were mentioned as predominating organisms.

3. The formation of the thick brownish discharge in the air passages for days after tracheotomy, so typical of the nondiphtheritic infections; and the lack of response to diphtheria antitoxin suggests that the few diphtheria bacilli found in cultures were probably only incidental.

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401 DAVIDSON BLDG.

LXXXIV.

UNUSUAL SYMPTOMS AND COMPLICATIONS OF MASTOID DISEASE.

By James Albert Morgan, M. D.,

Honolulu.

Case 1.—Subdural temporosphenoid abscess with recovery. Patient, age 24, with a history of recurrent attacks of chronic otitis media since the age of six. During a recent attack of influenza, the right ear again began discharging profusely. This was followed in a few days by swelling and tenderness over the upper mastoid region. At this time he was examined by a fellow physician who made an opening over the mastoid tip. One month later, when I was asked to examine him, I found a thick indurated area, in the center of which was a sinus from which thick, greenish, foul smelling pus was discharging. Exploration revealed a large sequestrum, which was readily removed entire. The lateral sinus was then brought into the field. Beneath the temporosphenoidal lobe was found a large subdural circumscribed collection of pus. The abscess cavity was evacuated and gently packed. Shock for a time was marked, but he reacted promptly and went on to a most satisfactory operative recovery.

While still in the hospital, at the end of six weeks he began to show a daily rise of temperature. Pulmonary symptoms and later the tubercle bacilli were found. Six months later the patient succumbed to a pulmonary hemorrhage.

The interesting points in this case were Nature's removal of the mastoid disease, by the formation of a large sequestrum, and the symptoms of pulmonary tuberculosis appearing later, most likely the primary cause.

Case 2.—Mastoid disease with perisinus abscess and complicated by facial erysipelas. Mrs. J. H., age 47, had been ill for one month, with elevated temperature and cough. One week before coming to me a purulent discharge from the right ear

gave relief to an acute pain of two days' duration. There was swelling over the mastoid of the corresponding side. When I made my first examination, there was a purulent otorrhea, right side, but no mastoid tenderness and no edema. The left mastoid area showed a general tenderness and edema, and there was a bloody discharge from the left ear. Radiogram showed the cells of the right mastoid process clear, but there was a complete clouding of the entire left mastoid area, which might signify a sclerosis. The patient was admitted to the hospital for observation. The temperature ranged from 101 to 104 degrees, with a morning drop. The white cell count was about 12,000. As the temperature remained high and the patient became delirious, an operation was decided upon. The bone of the left mastoid process was found to be hard and ivorylike, making the use of the gouge and mallet necessary. The entire process was chiseled away down to the tip without encountering any cells. Pus was found in a narrow bony sinus extending from the mastoid antrum posteriorly and downward and into the lateral venous sinus. The wall of the sinus was necrotic and the sinus itself protected by a thick cranberry-like clot. The sinus was inadvertently opened, but packing stopped the hemorrhage and the operator was able to continue. The zygomatic area was also investigated but no cells were encountered. The packing in the lateral sinus was left in place for nine days, and when removed there was only a slight oozing of bloody serum. On the day following operation a swelling of the left side of the face ushered in a rapidly spreading erysipelas, which extended to the left eye, into the scalp above, over the left ear and lastly into the field of operation. The temperature reached 105 and the leucocyte count was 25,000. Fortunately, the process stopped at the upper end of the mastoid wound and extended across the face, nose and orbit to the right ear. The erysipelas continued a week with temperature high and patient very restless. The wound finally became healthy and closed.

The interesting points in this case were as follows:

1. The almost entire absence of mastoid cells.

2. The bony sinus extending from the mastoid antrum to the lateral sinus. An unusual osteogenesis.

3. The complicating erysipelas.

Case 3.—Mastoid perforation with only remote middle ear infection.—Patient, age 35. About two months prior to this mastoid trouble he suffered an acute attack of right sided otitis media. The tympanum ruptured spontaneously and the usual discharge followed. Within three weeks the ear drum healed with but little scar formation. After a month there occurred a swelling upward and backward to the right ear which extended into the scalp of the right parietal region. The hearing remained unimpaired and no rise in temperature was noted. The leucocyte count was 8,800. After the swelling had persisted for three days, a small incision was made but no pus was found, and the following day a deeper incision was made with the same negative result. An X-ray revealed obliteration of the mastoid cells. The patient was admitted to the hospital and the affected mastoid was opened. A large pocket of pus was found under the scalp of the right parietal region. On uncovering the bone, a perforation about a quarter of an inch in diameter was found in the bone about one-half inch above the mastoid tip. The lateral sinus was exposed for about one inch, and one large mastoid cell filled with granulations and pus extended well into the mastoid tip. The middle ear was investigated and found clear. The postoperative period was uneventful except for a slight rise in temperature due to a further accumulation of pus under the scalp. The point of interest in this case was the deposit or focus in the mastoid process at the time of the attack of acute otitis media two months before. Also, that the primary focus of infection was sufficient to cause necrosis and perforation. Further, that there was no rise in the temperature or increase in the leucocyte count.

Case 4.—Multiple brain abscesses from chronic mastoiditis and maxillary sinusitis. M. H., age 35, has had nasal obstruction and a thick yellowish discharge from either nostril throughout the previous year. He has no recollection of any ear trouble whatsoever. Four months ago the left temporal region commenced to swell, but there was no pain or elevation of the temperature. He suffered fainting spells and had a continuous nausea. The swelling was becoming more prominent.

My first examination revealed a large more or less firm tumor in the left temporal region extending from the orbit backward for about six inches. The bone of the skull at the margins of the tumor felt as if excavated and X-ray diagnosis of cerebral hernia was made. The blood Wassermann test was strongly positive, and a necrosis of the skull with resulting hernia cerebri was considered. Not being quite satisfied with this diagnosis, a sterile needle connected with a syringe was carefully inserted into the tumor and a thick greenish yellow pus was withdrawn. An incision was then made at the lower margin of the tumor and fully one pint of pus was evacuated. Examination of the bone brought to view a hole about one-quarter of an inch in diameter. Then the question arose as to the origin of so much pus. The wound drained satisfactorily but the temperature continued high. At this time other abscesses began to appear, three in the parietal region on the line with the external orbit, and the fourth one in the left occipital region, about two inches to the left and just above the line to the external occipital protuberance. These abscesses contained pus of a similar appearing character. While these pus cavities continued to drain freely, there was no fall in the temperature. At this time, the left maxillary sinus was explored and practically the entire nasal wall was found to be one necrotic mass. The anterior and posterior ethmoid cells, including the middle turbinate and wall of the sphenoid sinus, were necrotic and bathed in pus. The entire left nasal cavity with all of its sinuses was cleaned out as thoroughly as was possible at the time. The temperature continued high, and further search was made for other areas of infection. The ear drum was intact and the hearing was practically normal. The whole left side of the head was numb, and there was a deep seated burning sensation in it. Radiogram of the left mastoid showed the part slightly cloudy. It was decided to explore the mastoid on this side, and, upon opening it, a small amount of pus along the course of the lateral sinus was exposed. The sinus was then opened and found to be full of pus. The mastoid cells extending into the tip were perfectly healthy, and upon opening the mastoid antrum no trouble was found. The pus had burrowed its way through the skull at the posterior part of the mastoid process and escaped into the subperiosteal region. It had also

burrowed under a thick outer layer of bone and extended upward, perforating just below the zygoma, and formed a large abscess cavity under the scalp. During the subsequent month all the foci in the scalp, the mastoid and the nasal sinuses continued to drain freely. The temperature continued with its septic fluctuations. At the end of six weeks the patient sank into a state of coma and died from pyemia.

We concluded that the infection had its origin in the nasal accessory sinuses and that the abscess in the region of the mastoid process was secondary to the intracranial purulent sinusitis.

ROOM 48 YOUNG BUILDING.

LXXXV.

GUNSHOT WOUNDS OF THE MAXILLARY SINUS.

By Herman F. Lampe, M. D.,

New York.

At the United States Army General Hospital, No. 11, Cape May, N. J., eighteen cases of gunshot wound of the maxillary sinus required a radical operation. Some of the cases were operated on for the removal of foreign metallic fragments, others for the closure of a fistulous opening into the sinus and the remainder for an infection resulting from the injury.

In former wars, operations of the maxillary sinus were rare. In the American Civil War there were no specific cases of injuries to the maxillary sinus reported. However, statistics show that there were 3,312 fractures of the bones of the face resulting from gunshot wounds. Five hundred and fifty-five of these were of the superior maxilla, 157 of both maxillæ and 200 the maxilla not stated. There were also 1,190 wounds of the orbital region. (Medical and Surgical History of the War of the Rebellion.) Probably the maxillary sinus was operated upon in very few of these cases. In the war 1870-1871 only 14 cases of maxillary sinus wounds were reported. Among 99,566 wounded, there was one wound of the maxillary sinus to 7,112 wounds, or 0.014 per cent. (Erfahr.) In the Balkan War (1912-1913), three cases of wounds of the maxillary sinus among 15 complicated wounds of the nose were reported. (Dimitriadis.) The number of wounded was 50,634; therefore, there was one wound of the maxillary sinus for every 16,878 wounds, or 0.0059 per cent of the total number. In the World War many cases of injury to the maxillary sinus have been reported. M. Weingaertner reported 100 cases, Schmidt 65, O'Malley 50, Guisez and Oudot 34, E. Glas 32, Torrini 22, Canuyt 20, A. Onodi 17, Vandenbossche 16, G. Hofer 15, H. Marx 13, A. Blau 8, A. Gutmann and L. Grünwald 7 each, Kuttner 6, A. Zimmerman, Albert and Berruyer 5 each, Sieur and Rouvillois 4, and Bobone, Surrel, Green,

Roy, Tretrop, Fletcher, A. Denker, H. Haenisch, O. Körner, Mayrhofer, Lubliner, Cohen, Lautenschläger, Gamaleia and de Groot report 1 to 3 cases each. These cases included all injuries to the maxillary sinus.

Nature of the Injury.—The injuries to the sinuses and the surrounding structures varied greatly in extent and character. Shell fragments were found in 5 of the sinuses operated. Fourteen of the cases were caused by fragments of high explosives and 4 by machine gun bullets. The fragments usually entered through the cheek and caused a fistula which persisted until the sinus was opened and drained. After the fistula healed, there was usually a depressed scar that remained, and this had to be removed by a plastic operation. In several cases the missile passed from one sinus through both nasal fossæ into the other sinus, thereby leaving an opening for drainage into the nasal cavity. In 6 cases there was a fistula leading from the oral cavity into the sinus. These were closed by plastic operations. In 7 cases an eye was also destroyed by the missile. In 2 cases the missile in its course pierced the mastoid, and, besides the sinus operation, a radical mastoidectomy was necessary. In one case the missile entered about three inches in front of the ear, pierced the sinus and carried away the columnal ala in its exit. In 2 of the cases it was necessary to perform an operation on both sinuses. Twelve cases were on the right sinus and 4 on the left. In 1 case the facial nerve was destroyed, and in 2 cases it was partially destroyed. In one series of cases reported by Guisez and Oudot, in 18 cases out of 34 the projectile hit the superior maxilla or the malar bone directly. In O'Malley's cases, the right sinus was involved in 23 cases and the left in 27.

Symptoms: Feeling of pressure in the cheeks and pain at some point with dull headache were usually present. There was usually swelling within the nares, adhesions and a purulent discharge in the middle meatus. Injuries to surrounding structures often complicated the picture. In cases of long standing the symptoms were somewhat obscure. The most common complications were suppurative processes, necrosis and fistulæ. Slight hemorrhage sometimes occurred, especially in attempts to remove missiles lodged in the cavity of the sinus.

Diagnosis: The diagnosis was made with little difficulty with the aid of rhinoscopy, diaphanoscopy, suction, puncture with irrigation and the X-ray.

Treatment: A great many cases not reported here were treated conservatively with excellent results. This treatment consisted of the puncture and irrigation of the sinus, the separation of adhesions in the nares and the removal of obstructions such as hypertrophied turbinates and the correction of deflected septums. When these measures failed, it was necessary to open the sinus through the canine fossa. Foreign bodies were removed in this manner, except in two cases where they were removed through a fistulous opening in the palate, and in one case through a similar opening below the orbit. The Caldwell-Luc method (slightly modified) was used in the remaining cases. After opening the sinus through the canine fossa, the cavity was carefully explored. Pus and granulations were removed by wiping with sterile gauze. Foreign bodies were removed with forceps or gently with a curette, and in practically all cases the mucous membrane was not disturbed, as in none of these cases did it appear sufficiently involved to warrant its removal. The inferior turbinate was not disturbed, but the entire nasoantral wall beneath it was removed. The incision through the canine fossa was sutured, and drainage was carried on through the intranasal opening. In the after treatment, the packing was removed, generally on the fifth day, and irrigations of warm normal saline were employed. Guisez and Oudot stated in their paper that the Caldwell-Luc operation was well adapted to the radical cure of maxillary sinusitis. Berruyer, Canuyt and Green employed the Caldwell-Luc technic, while Schmidt used Denker's method with modifications.

CASE HISTORIES.

Case 1. Diagnosis: Gunshot wound right temporal region, orbit, maxillary, sinus and nose, resulting in destruction of right orbit and contents, infection of right maxillary sinus with fistula formation and deformity of cartilaginous portion of nose.

History: Private E. H., while making a night attack with his company on July 16, 1918, at Chateau Thierry, was struck in the right eye by a piece of high explosive. He was rendered

unconscious for several hours and was later taken back to a first aid station, where the wound was cleansed and partially sutured.

Examination: A healing sulcus, about 3 cm. wide, extended from right zygoma forward through the right orbit into upper part of right cheek; the contents of orbit were absent and the upper lid much swollen and prolapsed. Parts of the external wall and floor of orbit were missing, thus making a large opening into the maxillary sinus. The cartilaginous portion of the nose was scarred and the tip drawn downward. Both vestibules were much contracted. A small amount of pus was in the middle meatus. The X-ray report showed some pus escaped from this opening and the right maxillary sinus cloudy.

Treatment: The maxillary sinus was irrigated daily for about two months. The external scar healed and the fistula contracted but never entirely closed. A slight discharge from the maxillary sinus still persisted. On December 2, 1918, a bone and cartilage rib graft was placed beneath the nasal bridge to correct the deformity, and on January 15, 1919, the maxillary sinus was opened through the canine fossa and some granulations and necrotic bone removed.

Result: Two weeks later the maxillary sinus was free from pus and the patient was transferred to the Plastic Surgery Department for further work on the orbit.

Comment: In this case the radical operation was delayed with the hope of clearing up the infection with irrigations. However, this failed, and it was finally necessary to operate to effect a cure.

Case 2. Diagnosis: Gunshot wound left maxillary sinus, nasal septum, nasolacrimal duct and right ear, resulting in infection of the left maxillary sinus, adhesions in the right nasal fossa, collapse of the right external auditory canal and right facial paralysis.

History: Major G. M., on September 25, 1918, at Bellcourt, during the Hindenburg drive, received a shrapnel wound; the fragment entered about one-half inch below the inner canthus of the left eye, perforated the nasal septum, injured the nasolacrimal duct, passed through the right maxillary sinus without apparently injuring it and lodged beneath the

skin under the right mastoid. This caused a collapsed external auditory canal and a right facial paralysis. He was unconscious for a day and a half. Three days later he was given an anesthetic and pieces of shrapnel were removed from the wound, also a small piece of bone was taken from the right external auditory canal. At this time the right ear was totally deaf, and there was a discharge from the canal. On October 29, 1918, a simple mastoidectomy was performed on the right side. He remained in the base hospital in France until December 8, 1918, at which time he sailed for the United States.

Examination: There was a discharging fistula beneath the left eye, leading into the left maxillary sinus; the left nares showed a purulent discharge and a synechia of the nasal septum to the nasal wall. There was a complete facial paralysis and a collapsed right external auditory canal. The X-ray showed the left maxillary sinus cloudy and the presence of a small foreign body in its upper part.

Treatment: On February 10, 1919, a radical operation was done on the left maxillary sinus and the piece of shrapnel was removed with granulations. At the same time a modified radical mastoidectomy was done on the right side. The usual postoperative treatment was carried out. On April 5, 1919, it was necessary to perform a submucous resection and do a partial ethmoid exenteration on both sides to establish better nasal drainage.

Result: After the latter nasal operation the patient made a rapid recovery. The fistula into the left maxillary sinus remained closed and the scar was removed by plastic surgery. The facial paralysis did not improve, and an anastomosis with the hypoglossal nerve was planned.

Comment: This case showed particularly a great amount of destruction to surrounding structures. Two operations were done before entering the hospital at Cape May, four while on the service there and another yet to be done in the Neurologic Department.

Case 3.—Diagnosis: Gunshot wound of the right external auditory canal, right maxillary sinus and mouth, causing infection of the right mastoid and maxillary sinus, compound comminuted fracture of the right maxilla and mandible, loss

of three upper molars on the right and second upper incisor on the left, small oral fistula into maxillary sinus, otitis interna and partial right facial paralysis.

History: Private A. A. was struck with a machine gun bullet on October 10, 1918, while in the Argonne Forest. The missile entered the right external auditory canal, passed through the right maxillary sinus, fracturing the superior maxilla and the mandible, and passed into the mouth, carrying away three upper right molars, and, upon leaving its exit, knocked out the left upper second incisor. Trench mouth developed in a very serious form, and no operative work except for emergency treatment was done before entering the hospital at Cape May.

Examination: The nose contained no secretion. In the mouth the right upper molars and underlying alveolus were present. The gums were ulcerated. All teeth were out of occlusion, due to displacement of the right superior maxilla; the right external auditory canal was occluded with granulations. A probe entered the parotid fossa, from which pus exuded. Partial right facial paralysis was present. The right ear was deaf. An X-ray picture showed the right maxillary sinus very cloudy and the articulation of the right mandible shot away. The mastoid was also reported cloudy.

Treatment: On March 28, 1919, a radical maxillary sinus operation was done on the right side. The walls were thick and dense. The opening into the mouth was curetted and the edges sutured shut with mattress sutures. There was a fistula extending from the maxillary sinus immmediately beneath the orbit into the parotid fossa. On April 28, 1919, a radical mastoid was performed on the right side.

Result: The maxillary sinus healed entirely in about two weeks, and the discharge from the parotid fossa ceased immediately after the operation. The fistula into the mouth remained closed. After the mastoidectomy there was marked improvement in the facial paralysis condition.

Comment: In this case there was also a great amount of damage to surrounding structures.

Case 4. Diagnosis: Gunshot wound in left side of face, causing destruction of left eye and fracture of orbit. Large foreign

body in right maxillary sinus, perforation of nasal septum, intranasal openings and infection of maxillary sinuses.

History: Private W. W. H., on July 20, 1918, near Soissons, while his company was forming a skirmish line to pass through a barrage, was knocked down and partially buried by a high explosive shell. Immediately following this another shell exploded, about a rod away, and a fragment passed through the brim of his helmet and entered the left eye. Several small pieces were embedded in the soft tissue of the left cheek and side of the nose. The patient was conscious and walked back to a dressing station with the aid of a runner. The remains of the left eye and several shell fragments were removed three days later. He was taken ill on board the transport for the United States, and, after running a high temperature for several weeks, developed a phlebitis in both legs. Upon being admitted to hospital at Cape May he was just beginning to walk.

Examination: There was some discharge from left naris, and a synechia was present between the septum and the left inferior turbinate, about 3 cm. from the vestibule. There was a perforation through the septum just behind this synechia, and a probe could be passed through this perforation into the left maxillary sinus. There was also a small perforation into the right maxillary sinus beneath the inferior turbinate, just opposite the perforation in the septum. The left eye was missing, and a V shaped piece absent from the left lower lid and the underlying bony structures. The X-ray showed both maxillary sinuses clear and revealed a metallic foreign body in the right maxillary sinus.

Treatment: The adhesion in the left nostril was separated and the maxillary sinus irrigated through the openings made by the missile. The solution returned clear. On February 7, 1919, a radical operation was done on the right maxillary sinus and a metallic fragment, 1 by 1½ by 2/10 cm. was removed from the lower portion. A small amount of granulation tissue was also removed.

Result: There was never any discharge from the maxillary sinus following the operation, and the patient was transferred to the Ophthalmic Department for restoration of the lower lid.

Comment: In this case the infection in the sinuses cleared

with saline irrigations through the intranasal openings made by the missile, and the radical operation was done only for the removal of the foreign metallic fragment.

Case 5. Diagnosis: Gunshot wound of the left orbit and cheek, causing destruction of left eye, ectropion of left lower lid and foreign body in left maxillary sinus.

History: Private F. R., while in the front line trenches at Chauteau Thierry on July 16, 1918, was struck in the face by three pieces of high explosive, the first destroying the left eye and fracturing the lower border of the orbit, the second striking the mandible just below the condyle and anterior to the auricle, and the third striking the right lower eyelid. After the injury he was able to walk back to the dressing station.

Examination: The left eye was absent. There was an ectropion of the lower lid and a depression of the socket, due to loss of bone in the lower border of the orbit. There were healed scars, which were caused by the second and third missiles. A probe could be passed through the lower border of the orbit into the maxillary sinus; also there was an opening into the maxillary sinus beneath the left inferior turbinate. There was no secretion present. An X-ray picture showed an irregular metallic fragment over the left maxillary sinus.

Treatment: On February 3, 1919, a radical operation was done on the left maxillary sinus, and an attempt to remove the foreign body through the canine fossa was unsuccessful. On February 21, 1919, after the sinuses had healed, the foreign body, a piece of shell fragment, 1 by 2 cm., was removed through the fistulous opening beneath the eye.

Result: The sinuses remained free from infection and the fistula healed rapidly. The patient was later transferred for the plastic restoration of the lower lid.

Comment: The sinus in this case showed no infection, although it was in communication with the outside air through two abnormal openings.

Case 6.—Diagnosis: Gunshot wound right side of face, resulting in infection of right maxillary sinus, fistula into sinus and foreign metallic bodies within the sinus.

History: Private T. P., stated that his company was making an advance on July 19, 1918, near Chateau Thierry, when he was struck in the right cheek by a machine gun bullet. The

bullet lodged in the soft tissue just external to the angle of the jaw, and was removed two days later. At the same time several pieces of shrapnel were removed from various parts of the face. The patient stated that the shelling had been very severe, but he did not remember being hit by shell fragments. About a week after the injury the right cheek became swollen and a fistula developed about two inches below the entrance of the bullet. From time to time several pieces of metallic fragment were removed from this sinus.

Examination: There was a large fistula in the right cheek about 2 cm. below and 1 cm. inward from the external canthus at the junction of the right malar bone with the maxilla. A probe could be passed into the maxillary sinus and ethmoid. A profuse purulent discharge was present. There was a small amount of pus in the right middle meatus. The X-ray showed a small metallic foreign body in the right maxillary sinus and the presence of pus and granulations.

Treatment: On December 2, 1918, small shell and loose bone fragments were removed from the maxillary sinus through the fistula. The condition did not clear, so on January 15, 1919, a radical operation was done. Granulations and a small shell fragment were removed. On February 21, 1919, a plastic operation was done on the opening in the cheek.

Result: At the end of a month the maxillary sinus was free from discharge, and although in this case healing was rather delayed, the outcome was satisfactory. The plastic resulted in practically no deformity, and the patient was discharged from the service as cured on March 18, 1919.

Comment: In this case an attempt was made to remove the fragments through the fistula. All but one were removed in this manner. However, it was necessary to do a radical operation to remove the last particle.

Case 7.—Diagnosis: Gunshot wound right side of face, resulting in infection of both maxillary sinuses, perforation of nasal septum, intranasal opening into both maxillary sinuses, bilateral nasal synechia, rupture of both choroids and ectropion of right lower lid.

History: Sergeant J. D. stated that while his company was reeling a counter attack in the Champagne sector on July 15,

1918, he was hit with a shell fragment, which entered the face just below the right eye, passed through the right maxillary sinus, nasal septum, left maxillary sinus and lodged immediately anterior to the left condyle and below the zygoma. The patient was almost blind for some time following the injury. Since then the sight has improved considerably. The day following the injury the shell fragment was removed from the left cheek, and later a small piece of shell was removed from the right cheek. On July 24, 1918, an exploratory operation was done on the left maxillary sinus to locate a foreign metallic body that had been reported by X-ray. No foreign body was found, so an external incision was made for drainage. Trismus developed and continued until the patient's admission to Cape May.

Examination: There was an ectropion of the right lower lid. No restrictions of any of the normal jaw movements were present. The right inferior turbinate was adherent to the nasal septum throughout its entire length. The left inferior turbinate was adherent for about 1 cm. to a basal spur of the septum. This began about an inch from the vestibule. There was a large opening into both maxillary sinuses above the inferior turbinates, and a large perforation of the bony septum. Mucopurulent material was present in both nares. X-ray showed both maxillary sinus and ethmoids cloudy.

Treatment: On November 29, 1918, the synechia in both nares was cut and Simpson's splints inserted. There was a tendency for the synechia to reform, and it was necessary to separate it several times before the nostrils remained free. The sinus infection did not respond to the daily irrigations, so on April 10, 1919, a double radical antrum operation was performed. At the same time both ethmoid labyrinths were exenterated. All sinuses were found filled with pus and granulations.

Result: With the usual postoperative treatment, the sinuses cleared up rapidly, and the patient was transferred to the Plastic Department for the removal of the facial scar and the correction of the ectropion of the right lower lid.

Comment: In this case a shell fragment pierced both maxillary sinuses, resulting in an infection that required a radical operation for a cure.

Case 8.—Diagnosis: Gunshot wound of both cheeks, resulting in loss of alveolar processes and intraoral fistulæ of both maxillary sinuses.

History: Private J. K., while with the A. E. F. at Soissons, on August 27, 1918, was struck with a machine gun bullet in the left cheek. The missile passed through the left maxillary sinus into the oral cavity, taking away the alveolar processes on both sides and passing out through the right cheek at the level of the floor of the right maxillary sinus. Only emergency treatment was given at that time.

Examination: There was a large opening into the right maxillary sinus from the mouth through the alveolar process and a smaller opening into the left maxillary sinus. Both alveolar processes had been carried away. Upon irrigation there was a clear return from both sinuses. There was no intranasal opening into either sinuses, nor was there any pus in either nostril. An X-ray picture showed the sinuses clear.

Treatment: The fistula into the left maxillary sinus closed with local remedies and cautery. On May 21, 1919, with a local anesthetic the fistula into the right maxillary sinus was closed. By working through the opening, a flap, including both bone and mucous membrane from the nasoantral wall beneath the inferior turbinate, was turned down and sutured with silk to the edges of the fistula.

Result: The patient made an uneventful recovery. As neither maxillary sinuses were ever infected, no postoperative irrigations were used. The flap held perfectly and the fistula remained closed. Later, the patient was transferred to the Oral-Plastic Ward for a dental plate.

Comment: This case is interesting and unusual for the reason that the missile passed through both maxillary sinuses without penetrating the nasal cavity. It is also interesting to note that infection did not occur in either sinus, even though there was a fistulous opening into both from the mouth.

Case 9.—Diagnosis: Gunshot wound right side of face, eye and orbit, resulting in loss of eye and infection of maxillary sinus.

History: Private L. R., while with the A. E. F. in the Argonne Forest on September 29, 1918, was struck with a piece of high explosive in the right eye and right cheek. On

October 30, 1918, the eye was enucleated and some bony fragments were removed from the maxillary sinus through the nostril. The patient does not know whether or not a metallic fragment or fragments were removed at that time. Since then there had been tenderness over the right sinus and a profuse discharge from the right nostril.

Examination: Healed scar below the right orbit. Right eye missing, patient wearing artificial eye. Marked tenderness over right maxillary sinus. Free pus was present in middle meatus of the right nostril. The X-ray reported the right maxillary sinus very cloudy and other sinuses negative.

Treatment: On February 26, 1919, a radical operation was performed on the right maxillary sinus. The cavity was found to be filled with pus and granulations. The modified Caldwell-Luc technic was used.

Result: After using postoperative irrigations for a period of two weeks, the sinus was free from pus.

Comment: This case showed nothing unusual.

Case 10.—Diagnosis: Gunshot wound left orbit and eye and right cheek, resulting in infection of both maxillary sinuses, loss of left eye, nasal adhesions and a right sided dacryocystitis.

History: Private F. R., while with the A. E. F. in the Verdun sector on September 28, 1918, was struck with a machine gun bullet in the outer side of the left orbit. The missile passed through the left eye, destroying it, through the left maxillary sinus and nose, then made its exit through the right maxillary sinus. The left eye was enucleated at this time and other emergency treatment given.

Examination: There were adhesions present between the nasal septum and both middle and inferior turbinates. Free pus was found in the left middle meatus, but none was found in the right nares. There was tenderness over both maxillary sinuses. They were dark on transillumination and the X-ray reported them very cloudy.

Treatment: On February 12, 1919, the nasal adhesions were separated under local anesthesia. On April 23, 1919, a radical operation was done on the right maxillary sinus. No pus was found, but a few bone fragments and some granulation tissue were removed. On May 9, 1919, the radical operation was done

on the left sinus. Here free pus and granulations were encountered.

Result: Both sinuses cleared rapidly following the operations. The patient did not desire an operation for the eye condition, so was discharged from the service.

Comment: In this case both maxillary sinuses were infected and required a radical operation.

Case 11.—Diagnosis: Gunshot wound right side of face, resulting in infection of right maxillary sinus, ectropion of right lower eyelid and adhesions between nasal septum and right middle and inferior turbinates.

History: Sergeant P. M., while with the A. E. F. in Argonne, on October 13, 1918, received a penetrating wound of the right lower eyelid, maxillary sinus and nares. Only emergency treatment was instituted at this time.

Examination: Ectropion of right lower eyelid, healed scar below right eye, synechia between right middle and inferior turbinates and a purulent discharge from the right middle meatus. Transillumination showed the right maxillary sinus cloudy. The radiogram showed both ethmoids shattered inwards, numerous small foreign bodies in right ethmoid and the right maxillary sinus very cloudy.

Treatment: The patient was first admitted to the Ophthalmology Ward, where a blepharoplastic or blepharorrhaphy plastic was performed on the right lower lid on January 18, 1919. On February 12, 1919, after being transferred to the Otolaryngologic Department, a radical operation was done on the right maxillary sinus. Pus and granulation tissue was encountered. At the same time part of the right middle turbinate and the ethmoid labyrinth were removed, establishing free drainage in the right nares.

Result: Only a few irrigations were necessary to clear up the condition, so patient was discharged as cured on February 25, 1919.

Comment: In this case foreign metallic bodies were found in the ethmoids, while none were found in the maxillary sinuses.

Case 12.—Gunshot wound of left side of nose and right cheek, resulting in infection of right maxillary sinus and both

ethmoids, loss of right eye, fistulæ leading into ethmoids and right maxillary sinus and metallic foreign bodies in both ethmoids.

History: Private E. C., while with the A. E. F. in the Verdun sector, on October 15, 1918, received a penetrating wound in the left side of the nose, the missile passing through the ethmoids, right maxillary sinus and destroying the right eye. Emergency treatment and the removal of the right eye was done at this time.

Examination: Small opening left side of nose and a large opening on right, both leading into ethmoids. There was also a small opening at lower margin of right orbit leading into the maxillary sinus. The right eye was missing. Free pus was found in the right middle meatus. The X-ray picture showed both ethmoids and the right maxillary sinus cloudy, also a small metallic foreign body in both the right and left ethmoid region.

Treatment: Operative work was delayed after admission on account of a pseudodiphtheroid infection of the wound. After the organism was passed through a guinea pig and found to be nonpathogenic, an operation on the right maxillary sinus was done on April 30, 1919. The sinus was filled with pus and granulations. At the same time the ethmoids were operated on and the foreign bodies removed.

Result: This case cleared very slowly, probably on account of the combined maxillary sinus and ethmoid operation. However, after six weeks of irrigation, the patient was well enough to transfer to the Plastic Department for further operative work.

Comment: This case also presented foreign metallic bodies in ethmoids and none in the maxillary sinus.

Case 13.—Diagnosis: Gunshot wound left side of face, resulting in infection of left maxillary sinus and loss of columnal ala.

History: Private G. T., while with the A. E. F. in the Argonne Forest on October 25, 1918, received a wound in the left cheek about three inches anterior to the ear. The missile pierced the left maxillary sinus and made its exit through the nose, carrying away the column ala. At Nieully, a short time after the injury, an attempt was made to form a new columella

from a pedicle flap taken from the forehead. This was unsuccessful.

Examination: A large healed scar in the left cheek, which was bound down tightly with adhesions. There was obliteration of the left nares and the columnal ala was missing. Free pus was found in the left middle meatus. The radiogram showed the left maxillary sinus very cloudy and a small portion of the outer wall of the left maxillary sinus and alveolar process anterior to the third molar missing.

Treatment: While on a furlough the first part of April, 1919, a large abscess formed over the left cheek. This was incised and was discharging profusely when patient returned to the hospital. A probe introduced through the opening passed on into the maxillary sinus. On April 29, 1919, a radical operation, left, was performed. The scar tissue binding down the cheek was loosened up and a large opening found leading into the maxillary sinus beneath the abscess. Both pus and granulations were found in the sinus. The fistula leading into the sinus through the cheek was curetted and sutured shut.

Result: After irrigating the sinus through the nasal opening for one month the flow returned clear, and the patient was transferred to the Plastic Ward for the repair of the columnal ala.

Comment: This case differed very much from the others inasmuch as there was very little destruction to surrounding tissue except for the columnal ala.

Case 14.—Diagnosis: Gunshot wound left side of face, resulting in infection of left maxillary sinus, oral fistula into left maxillary sinus and loss of left alveolus.

History: Lieutenant W. W., while with the A. E. F. in the Argonne Forest on September 28, 1918, received a wound in the left side of the face which penetrated the left maxillary sinus and carried away part of the left alveolus and hard palate. A short while after the injury a piece of shell fragment was removed from the left maxillary sinus.

Examination: There was a healed scar below the left eye leading down toward the lip. Part of the palate on the left side was missing, and there was a small fistula leading into the sinus through the mouth. The radiogram showed the left maxillary sinus very cloudy.

Treatment: On May 2, 1919, a radical operation was done on the left side. The opening in the canine fossa was made high on account of the loss of the hard palate. Granulation tissue was found in the sinus but no free pus. Redundant tissue was removed from the upper lip and the oral fistula was sutured shut wth horsehair.

Result: With the usual treatment the sinus cleared rapidly and the oral fistula remained closed.

Comment: In this case the loss of the alveolus and part of the hard palate made the operation rather difficult. Very little bone was removed from the anterior wall, thereby making it necessary to work through a very small opening.

Case 15.—Diagnosis: Gunshot wound right side of face, resulting in compound comminuted fracture of nasal bones and right superior maxilla, loss of alveolar process with teeth extending from right bicuspid to right third molar, small metallic foreign body in right maxillary sinus and fistula leading from mouth into right maxillary sinus.

History: Private H. M., while with the A. E. F. in France, received two wounds of the face. One missile entered about 1¼ inches behind the angle of the right jaw, passing through the maxillary sinuses and the nasal fossæ and made its exit about an inch in front of the left external auditory canal; the other lodged in the maxillary sinus. Emergency treatment was given at that time.

Examination: There were small healed scars behind the angle of the right jaw and in front of the left external auditory canal. A large opening extended from the mouth into the right maxillary sinus through the hard palate. Nasal adhesions were present, and the nasal septum was badly deflected. The X-ray showed the left maxillary sinus clear and the presence of a small metallic foreign body in the right maxillary sinus. It also showed loss of part of the right superior maxilla and an opening into the sinus.

Treatment: On January 10, 1919, a radical antrum operation was done and a small metallic fragment was removed. The nasal adhesions were separated at this time. On January 28, 1919, a plastic closure of the oral opening was done by reflecting a flap of mucous membrane from the cheek. On April 3,

1919, a submucous resection was done to establish better nasal drainage.

Result: No postoperative irrigations were used in this case. The maxillary sinus never became infected and the oral fistula remained closed.

Comment: This case never became infected, although there was a fistula opening communicating with the oral cavity.

Case 16.—Diagnosis: Gunshot wound right superior maxilla resulting in infection of right maxillary sinus, fistulous openings into the sinus, one through the cheek and the other through the alveolar process, and a partial right facial paralysis.

History: Lieutenant J. Mc., while with the A. E. F. at Exermont, on October 4, 1918, received a wound in the right side of the face. The missile passed through the right maxillary sinus and carried away part of the alveolar process. Emergency treatment was given at that time.

Examination: There was a small depressed scar just below and internal to the right zygoma. A probe could be passed through a fistulous opening in this scar into the maxillary sinus. Three teeth were missing, and a fistulous opening led from the mouth into the sinus through the alveolar process. Free pus was present in the right middle meatus. The X-ray picture showed the right maxillary sinus cloudy.

Treatment: On March 27, 1919, a radical operation was done on the right side. Pus and granulations were encountered. The oral fistula was sutured shut with chromic catgut. On April 11, 1919, a plastic operation was done on the facial scar and fistula.

Result: After several irrigations the maxillary sinus was clear. The fistulæ remained closed and the facial plastic was successful, leaving little if any deformity. The facial paralysis entirely disappeared.

Comment: This case presented little if any difficulties in treatment and results were very gratifying.

Case 17.—Diagnosis: Gunshot wound of face resulting in infection of right maxillary sinus, loss of right eye, ectropion of right lower lid and perforation of nasal septum.

History: Sergeant E. V., while with the A. E. F. in the Argonne Forest, on October 9, 1918, was struck in the right

eye with a piece of high explosive. The missile passed into the right maxillary sinus, through the nasal fossæ, and made an exit through the left cheek just anterior to the auricle. The right eye was enucleated at that time.

Examination: The right eye was missing, and there was a fracture of the floor of the orbit. There was a perforation through the nasal septum, but no fistulæ into either maxillary sinuses. No pus was present in the nares. The X-ray showed the right maxillary sinus very cloudy.

Treatment: On March 27, 1919, a radical operation was done on the right maxillary sinus. It was found to be filled with fibrous tissue. No pus or granulation tissue were present.

Result: The condition cleared rapidly, and the patient was transferred to the Ophthalmology Department for a plastic operation on the right lower eyelid.

Comment: In this case the missile passed through both maxillary sinuses and only one became infected.

Case 18.—Diagnosis: Gunshot wound right side of face, resulting in infection of right maxillary sinus, oral fistula into right maxillary sinus and compound comminuted fracture of the right superior maxilla and the right mandible.

History: Lieutenant C. H. E., while with the A. E. F. in the Argonne Forest, on October 14, 1918, was struck with a piece of high explosive in the right cheek. The missile pierced the right maxillary sinus and passed into the mouth, leaving a large opening through the alveolar process. Only emergency treatment was given at this time.

Examination: There was a healed scar over the right cheek. A large opening led from the oral cavity into the maxillary sinus through the alveolar process. A seropurulent material was draining through this opening. The nares were free from any discharge. The X-ray showed the right maxillary sinus to be very cloudy.

Treatment: The sinus was cleansed and irrigated through the oral fistula daily for several weeks. There was no improvement with this treatment. On April 15, 1919, a radical antrum operation was done and the fistula was closed with chromic catgut sutures.

Result: Recovery from the operation was rapid, and the oral fistula remained closed.

Comment: In this class of cases, delay only added to the discomfiture of the patient. The operation should have been done earlier.

CONCLUSIONS.

In this series of cases six months was the average time that elapsed from the time of injury until the radical operation was done, and mainly for this reason there was no mortality. In the average case the sinus was free from discharge two weeks after the operation. The maxillary sinus could be traversed by a missile and unless the injured cavity had a patent communication with the nose, mouth or external air, or the trauma caused obstruction to the ostium of the sinus, no sepsis would result. In cases Nos. 5, 8 and 15 the sinuses all had abnormal communication with the outside air, and still there was no infection.

From these cases it is well concluded that when the maxillary sinus shows gross sepsis, it is necessary to open the sinus through the canine fossa and make free drainage into the nose. If a foreign body lies uncovered in the sinus it should be removed, otherwise it might lead to local inflammatory reaction. If the fragment is small and lies in the wall of the cavity and is covered by the lining mucous membrane it will not cause infection. The removal of foreign bodies is difficult in many cases. In case No. 5 it was impossible to locate the foreign body through the canine fossa, and a subsequent operation through the fistula in the cheek was necessary for its removal.

The eighteen cases just reported were operated upon by the members of the Otolaryngologic staff at Cape May, namely, Colonel Ingersoll, Major Berry, Lieutenants Bigelow, Longaker and Beard and the writer. To these men the writer wishes to extend his thanks for their encouragement in this work and for the honor of presenting the cases.

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LXXXVI.

TREATMENT OF LATERAL PHARYNGEAL BANDS FOR DEAFNESS BY X-RAY—RESULT OF ONE HUNDRED CASES.*

By D. Campbell Smyth, M. D.,

Boston.

In November, 1923, at the request of Dr. H. P. Mosher, an attempt was started to get together a series of 100 cases of chronic deafness and tinnitus having enlarged lateral bands of lymphoid tissue in the pharynx. We were stimulated in doing this by the paper read at Atlantic City by Dr. D. C. Jarvis, before the American Laryngological, Rhinological and Otological Society in May of the same year.

The chief object of undertaking this work was to attempt to arrive at some definite conclusion as to the actual good, if any, accomplished by X-ray treatment of those cases of chronic progressive deafness in which redundant lymphoid tissue was present in the nasopharynx, especially on the lateral pharyngeal wall near the opening of the eustachian tube.

It was rather surprising to find how difficult it was in the Out Patient Clinic of the Massachusetts Eye and Ear Infirmary to find suitable cases for treatment, such as Dr. Jarvis described in his paper. Evidently hypertrophy of the lymphoid tissue of the pharynx is not so prevalent around Boston as it is among the granite workers of Vermont. So it was, therefore, that considerable difficulty has been encountered in getting together the 96 cases which make up the series from which the conclusions in this paper are drawn.

The series comprise 96 cases treated at the Massachusetts Eye and Ear Infirmary and seven cases from my own private practice, making a total of 103 cases. Of this total number, seven did not complete the treatments, which leaves the 96

*Read before the American Otological Society at Montreal, June, 1926.

above mentioned. The X-ray treatments were all given by Dr. A. S. MacMillan, roentgenologist at the Massachusetts Eye and Ear Infirmary. His technic followed that of Dr. Jarvis and was as follows:

Two portals of entry for the X-ray are used, the right and left side of the neck over the upper pharynx and eustachian tube, the rest of the structures in the neck being protected by lead; care is taken to especially protect the parotid gland, not only on the side of entry of the ray, but directing the ray so that the gland on the right side will not be exposed from treatment given through the left, and vice versa. The factors used have been 8 inch spark gap, 5 milliamperes, 3 millimeters of aluminum filtration, 12 inch distance for five to eight minutes, according to age of the patient. Treatment given every ten days for six treatments.

On all the cases a hearing test, consisting of voice, whisper, high and low limit, Weber and Rinne, was done before treatment was started. Besides the above test, on the last thirty-two cases of the series, audiometer tests were done before and two weeks following the last treatment. In two of the cases two series of X-ray treatments were given.

The following points were noted in obtaining the history of these patients: (1) Age. (2) Sex. (3) Family history of deafness. (4) Duration of deafness. (5) Whether tinnitus was present. Then the condition of the pharynx was carefully noted on the patient's record.

Of the 96 cases treated, 83 had involvement of both ears, while in 13 cases only one ear was involved.

Another fact which is interesting is had I reported examination of the series about a year ago the per cent of improved cases would have run considerably larger, as some of the cases showing a distinct improvement that time by test have since shown a loss in the original improvement.

Where a tonsillectomy or adenoidectomy or septum operation was required by the patient it was either not done, or, if done, a number of months was allowed to elapse before the patient was placed in this group. The large majority of the patients, however, had had any such condition corrected long before I saw them.

I have endeavored to put down, on a series of cards here shown, the important points and statistics of the group.

DIAGNOSIS OF CASES TREATED.

Omsecch (Chronic middle ear catarrh)	28	
Omsecch with tinnitus	39	67
Omseca (Recurring acute middle ear catarrh)	6	
Omseca with tinnitus	5	11
Effoms	9	
Effoms with tinnitus	2	11
Nerve deafness	2	
Tinnitus without deafness	5	
	96	
Did not finish treatment	7	
Total	103	

SEX AND AGES OF PATIENT TREATED.

Males	54
Females	42
Youngest Patient	7 years
Oldest Patient	67 years

2 had 10 treatments
1 " 7 "
1 " 5 "
1 " 4 "
1 " 2 "
90 " 6 "

In Table I have used the abbreviations in common use at the Massachusetts Eye and Ear Infirmary. The abbreviation Omsecch refers to chronic progressive middle ear deafness, which is usually called catarrhal. Omseca refers to those cases of recurring tubal catarrh accompanied by deafness and usually tinnitus. The abbreviation Effoms refers to those cases of deafness showing dry middle ears, but scarring or perforation of the drum membrane.

CASES OF DEAFNESS FOUND IMPROVED BY TEST, AND CASES CLAIMING IMPROVEMENT.

Diagnosis	No. treated	Improved by treatment	Per cent	No. claiming improvement	Per cent
Omsecch	67	15	22+	17	25
Omseca	11	7	63+	8	73
Effoms	11	3	27+	4	36
Nerve Deafness	2	0	0	0	0
Total	91	25	27.5	29	31.4

I was rather surprised in analyzing these cases to find that the number of cases found actually improved by test and the number claiming improvement ran so closely together. I expected that a much larger number of patients would claim improvement for deafness than was the case. Evidently the psychologic factor does not enter much in this form of treatment. This table, therefore, makes the following one of much more value:

CASES CLAIMING IMPROVEMENT OF TINNITUS.

	No. Treated	No. Improved	Per Cent
Omsecch	39	13	33
Omseca	5	4	90
Effoms	2	2	100
Nerve deafness	2	0	0
Tinnitus without deafness	5	3	60
Total	53	22	41

The only way we have of knowing whether tinnitus is actually improved or not is by what the patient says. I think, after an analysis of the preceding table, that we are justified in believing that the figures of above table are approximately correct.

CASES IN WHICH LOW LIMIT WAS LOWERED.

	Cases treated	Low limit lowered	Per cent
Omsecch	67	6	9
Omseca	11	4	36+
Effoms	11	1	9
Nerve deafness	2	0	0

It will be seen from the above table that the low limit was lowered in one-third of the cases of recurring tubal catarrh. It was also lowered in six cases of chronic catarrh of short duration.

CASES IN WHICH UPPER LIMIT WAS RAISED.

	No. treated	Upper limit raised	Per cent
Omsecch	67	3	4
Omseca	11	1	9
Effoms	11	0	0
Nerve deafness	2	0	0

RINNE CHANGED — TO +.

	Cases treated	Rinne changed	Per cent
Omsecch	67	4	6
Omseca	11	4	36+
Effoms	11	0	0
Nerve deafness	2	0	0

Rinne was lengthened in quite a few other cases where it was still positive. Practically all cases showing improvement of deafness by test also showed a lengthened Rinne.

TABLE SHOWING RELATIONSHIP BETWEEN IMPROVEMENT OF HEARING AND IMPROVEMENT OF TINNITUS.

	Hearing improved	Per cent	Tinnitus improved	Per cent
Deafness, all types, 91 cases	25	27.5		
Tinnitus, 53 cases			22	41

DURATION OF DEAFNESS IN IMPROVED CASES.

	Duration.
Omsecch	None over 4 years.
	Mostly under 2 years.
Omseca	Short (6 months to 2 years).
	Mostly young people, 8 to 15 years old.
	One 47 years old.
Effoms	None over 4 years.

Of the 52 cases of Omsecch unimproved, most of these were long standing, 4 to 15 years.

The most striking thing about this table is the short duration of deafness where improvement was shown. Secondly, all the patients were young. Of course, in estimating the duration of deafness the patient's word must be accepted. In many of the long standing cases the patients had been coming to the infirmary for years, so that it was much easier to estimate the duration of deafness in the long standing cases than in the ones of short duration.

AUDIOMETER.

Cases tested	Improved	Per cent
32	7	22

		Duration of deafness
Omsecch	3	2 months to 1½ years.
Omseca	4	Short.

Twenty-five cases found unimproved by audiometer test were of long standing deafness, 4 to 15 years.

It will be noted from the above table that the per cent of cases shown improved by audiometer ran very closely with the per cent of cases found improved by the ordinary test. This is shown in Table 3. It will also be noted that the duration of deafness in the seven improved cases was short, whereas in twenty-five cases found unimproved they were of long standing duration.

CONDITION OF PHARYNX FOLLOWING TREATMENT.

	Total
Throat improved	64
Throat unchanged	32

In the 25 cases which showed improvement in hearing.

	Same	Improved
Throat	15	10

Curiously enough, there seemed to be no relation between improvement of the hearing and tinnitus and the macroscopic appearance of the pharynx, some of the cases showing most improvement of hearing showed no macroscopic change in the pharynx, and vice versa. Some cases in which the throat cleared up nicely showed no improvement in hearing.

This is contrary to Dr. Jarvis' third conclusion of his original paper, published in the ANNALS OF OTOLOGY, RHINOLOGY AND LARYNGOLOGY of December, 1924, which was as follows:

"As the throat condition is improved, in like amount there seems to be an improvement of the aural condition."

CONCLUSIONS.

1. Treatment of enlarged lateral bands of lymphoid tissue in the nasopharynx by X-ray seems to be an aid in cases of deafness or tinnitus of short duration.

2. In cases of recurring acute tubal deafness, it seems to be a decided aid.

3. Deafness of long standing (ten to fifteen years) showed no improvement in any of the cases treated.

4. The majority of patients improved were young, eight to fifteen years.

5. There seemed to be no relation between improvement of the hearing and tinnitus and the macroscopic appearance of the pharynx. Some of the cases showing most improvement of hearing showed no macroscopic change in the pharynx, and vice versa. Some cases in which the throat cleared up nicely showed no improvement in hearing.

6. This last observation bears out the fact that there is lymphoid tissue found in the eustachian tube, and it is probably due to the destruction of this tissue that some of the cases are improved.

375 COMMONWEALTH AVENUE.

LXXXVII.

THE INFLUENCE OF NEGATIVE PRESSURE IN THE SPHENOID ON THE OPTIC NERVE.*

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In the study of optic nerve disturbances from focal infection, the one great stumbling block has been the difficulty of explaining why an optic neuritis should occur when the posterior sinuses were practically normal. The radiographs of these sinuses seldom show pathology. Their mucosa usually appears normal and even a microscopic study reveals but inconsequential changes. Yet the opening of these apparently normal sinuses benefits the neuritis. This clinical fact has been recognized by all rhinologists having experience with these cases, and the literature is filled with reports of their brilliant results. The fact that such good results followed the opening of the sphenoids, either alone or in conjunction with the ethmoids, has led to the conclusion that this procedure removed the focus of infection, and that the sinuses, although appearing normal, were yet in some mysterious way responsible for the eye condition. Many, therefore, advocated the opening of normal sinuses. Volumes were devoted to the investigation of the anatomic relationships between the sinuses and the optic nerve, and while in a way this work was valuable, it led to erroneous conclusions. It placed the adjacent sinuses too much in the limelight to the exclusion of more definite but distant foci. When the countralateral relationships of the sinuses to the optic nerve were described, it gave rise to extremely radical but unwarranted surgical procedures, such as bilateral ethmoid and sphenoid exenterations for the relief of unilateral nerve disturbances. The fact that advocates of these radical procedures still exist leads me to discuss one phase of this subject that has not, as far as I know, been called to the attention of the profession. Even if it has been mentioned, it needs em-

*Read before the American Laryngological Association at Montreal on June 3, 1926.

phasis by repetition, as it helps to explain why the opening of the posterior sinuses, even if normal, benefits optic neuritis. This brings us to the title of the paper—"The Influence of Negative Pressure in the Sphenoid on the Optic Nerve."

It is a well recognized fact, as I have explained in several of my papers, that cases with optic neuritis usually have obstruction to ventilation and drainage of the posterior sinuses. This obstruction is usually produced by a middle turbinate wedged between the ethmoid wall and the septum. There is often a septal deflection to the affected side, although in some instances the septum may go to the opposite side and a compensatory hypertrophy of the middle turbinate takes place. Any of these conditions may so obstruct the normal openings of the posterior sinuses that negative pressure within them might readily ensue. This condition would probably favor the migration of the bacteria and toxins from the blood stream or lymphatics to the tissues adjacent to the optic nerve and a consequent neuritis might follow. This hypothesis would explain why we have a practically normal mucosa in most of these cases, as I could count on my fingers the sphenoids that appeared diseased among the many I have opened. The relief of the negative pressure and the depletion incident to the operation would naturally greatly benefit the neuritis. There are two phases of this theory of negative pressure that require elaboration—first, is it possible for this condition to exist within the posterior sinuses? Second, if it does exist, would this negative pressure favor the passage of the bacteria in the blood stream to the sheath of the nerve? I think it has been sufficiently proven by Billings and others that bacteria from most any focus may travel in the blood stream. As to the first phase —the possibility of a vacuum condition of the sphenoid—let us consider similar conditions in the other accessory sinuses. There is, thanks to Sluder's investigations, a well recognized condition in the frontal sinus brought about by closure of the nasofrontal duct and known as vacuum disease of the frontal sinus. Sluder also described ethmoid vacuum and considers it fairly common.

Brawley's description of the mechanism of negative pressure is so good that I will quote it rather than try to describe it myself. He says that "as a rule no history of nasal disease is

obtainable. Close examination will reveal a swollen, boggy turbinate or one which is anatomically so close to the lateral nasal wall as to press on the hiatus semilunaris and thus interfere with free interchange of air and free exit of normal secretion from the frontal and anterior ethmoid cells." He advocates resection of the middle turbinate to relieve this condition. "The etiology depends on the anatomic relationship of the middle turbinate to the hiatus semilunaris and the infundibulum. The air in the frontal and anterior ethmoid cells is imprisoned there by pressure of the middle turbinate against the lateral nasal wall, the turgescent tissues filling in the hiatus semilunaris and effectually blocking it. The lining mucous membrane of the sinuses absorbs the oxygen in the imprisoned air and thus creates a vacuum. This absorption results in negative pressure and consequent swelling of the lining membrane with increased blood supply to this region. Stasis to a greater or less degree results. Pressure of the congested tissue on the contained nerve endings, together with this stasis, produces the symptoms and results in reflex vasomotor disturbances in the circulation of the neighboring structures."

Negative pressure of the antrum, largely due to the painstaking investigation of Lynch, is now well recognized. He states that "the condition is the production of a vacuum in the antrum not depending upon a previous recent inflammation in that cavity, and not associated with any marked nasal lesion, such as active suppuration, polypi or new formation. Truly a nonsuppurative condition and a noninflammatory one, there being no evidences of any inflammatory state in the nose, simply a condition of hyperemia, produced by the negative pressure, and being entirely relieved as soon as complete ventilation of the cavity is established. . . . Granting, then, that this antral cavity is closed by some process in the soft tissues or bone, we may have examples to prove that the confined air will be absorbed in this cavity as it is in the ear. It is a common experience for the general surgeon to meet with a localized emphysema, and to see the air in the tissues gradually absorbed. . . . These absolute facts leave no doubt as to the probability of the existence of a vacuum in the antrum, if the only means of ventilation of the cavity, namely, through the

natural or accessory opening, is closed by some pathologic change and the confined air absorbed by the processes referred to above."

"While this closure may be accomplished by an acute tissue reaction to some invading infection, and may thus account for the headache that accompanies these conditions, the cases that form the basis for this article are all of the chronic, long standing type, and it is upon them I wish to lay particular stress, for they are far more likely to be overlooked in a search for the explanation of the varied symptoms they present."

"Of the fourteen cases that have occurred in my practice in the last eighteen months," says Lynch, "I was unable to find any gross nasal lesion that would lead to an examination of the antrum. In two there was a malposition of the middle turbinate, with a high deflected septum; the two others were incident to an atrophic fetid rhinitis."

"It is possible," says Lynch, "that the hyperplastic changes described by Uffenorde, Skillern and others might easily extend sufficiently far down the nasoantral wall to involve the opening into the antral cavity or produce some change in the lining membrane by extension through the fibrobony wall, accounting for the closure of normal and accessory openings in this way."

These hyperplastic changes are also found about the sphenoidal ostium and might readily play an important rôle in negative pressure in the sphenoid. In a recent communication from Dr. Lynch, in reply to my query as to his views on negative pressure in the sphenoid, he states: "I have seen four cases of the sphenoid in all of which, after opening, all symptoms disappeared."

The middle ear, however, seems to give us our strongest proof, for in this accessory sinus, if you will permit me to so designate it, we have a drum membrane through which we can see and study negative pressure. It is well known that closure of the eustachian tube is shortly followed by absorption of the air within the tympanum, and a partial vacuum results. The ear drum is retracted and the patient is conscious of something a little out of the ordinary in the ear. Should there be complete closure of the tube for some days, the ear becomes filled

with serum and we have what is known as a secretory ear. Reasoning from analogy, we thus have a well recognized condition of negative pressure in the frontal sinus, the antrum, ethmoids and middle ear, all brought about by closure of the ducts or ostia, swelling of the mucosa about the nasal openings of these structures often being sufficient to bring about this condition. It is not necessary in these cases to have an acute infection, although it occurs frequently when there is one. This fact is equally true in cases with optic nerve disturbances. In most instances some previous nasal infection antedates the optic neuritis. Reasoning from this, it would seem that closure of the sphenoidal ostium would produce negative pressure, even if the sphenoid itself was not actually involved.

While it is probable that this vacuum theory has been greatly overworked and that many obscure neuralgias have been erroneously attributed to negative pressure, there are, without doubt, a certain number of true cases. Many patients suffer from occipital headaches of obscure origin. Is it not possible that negative pressure in the sphenoid may account for some of these? I do not wish to overestimate its importance, for I too well know the tendency to do this with every new idea. It is probably better at present to let it remain simply as a theoretic possibility.

As to the second phase of this subject: Does negative pressure favor the neuritis? Here again we must reason by analogy. There are no large nerve trunks in close relationship to the frontal. The supraorbitals, however, do become sensitive to pressure. In the middle ear we again have our best evidence, for coursing along its inner and posterior wall is the facial nerve enclosed, like the optic, within a bony canal, and, like the optic, separated from its adjacent sinus by the thin bony wall of the fallopian canal. In closure of the eustachian tube there may be an exudate of serum. If this ear is ventilated by inflation or incision of the drum membrane, the mucosa quickly returns to normal.

Associated with an acute secretory ear there is occasionally an involvement of the facial nerve, known as Bell's palsy. In most instances this palsy comes on in conjunction with an acute secretory middle ear. The negative pressure within the tympanum seems to favor the migration of bacteria from the

blood stream to the sheath of the nerve. Reik claims that in all cases incision of the tympanic membrane—i. e., ventilation of the middle ear—hastens recovery. Of course, we all know of many instances in which spontaneous recovery of the facial palsy occurs similar to the recovery of a retrobulbar neuritis. In both instances we have a neuritis causing in the one facial paralysis and in the other blindness. The facial nerve is not a highly organized structure like the optic, and regenerates even after several months, while optic atrophy not infrequently follows an optic neuritis of short duration.

The etiology of Bell's palsy has been under considerable controversy, like that of optic neuritis, but cases have been reported by Dabney where rapid recovery followed the removal of some distant focus of infection. I have seen such cases following tonsillitis, and I doubt not that if we were more painstaking in searching for a focus it could usually be found. In the Bell's palsies spontaneous recovery being the almost universal rule, no great effort is made to investigate them. If bacteria from some distant focus reaches the facial nerve; if, and as is usual, this happens when there is negative pressure within the middle ear, does it not seem logical to conclude that a similar condition of negative pressure within the sphenoid favors migration of bacteria and toxins to the optic nerve? If this supposition is correct, it should exert an enormous influence on the method of handling cases of optic nerve involvement. If we will but admit that a closed sphenoid favors the invasion of the optic nerve by bacteria from the blood stream, the first and logical thing is to eliminate the focus which feeds these bacteria to the blood. The elimination of this focus should be followed by a subsidence of the neuritis and a return of the vision. In cases recovering spontaneously we probably have a transitory focus, acute rhinitis, tonsillitis, etc. When there is a constant focus, chronic retrobulbar neuritis and atrophy follow.

The treatment of these cases may, for convenience, be considered under three headings:

First—Probably 50 per cent of the cases would recover spontaneously. To submit these to any serious operative procedure not definitely indicated by the pathology present, would be not only unnecessary but needless and meddlesome interference.

When some definite focus is found, as infected teeth or tonsils, removal is indicated, irrespective of the eye trouble. When no definite focus is discovered local treatment by astringent sprays and ointments is sufficient.

Second—In about 30 per cent of the cases there is, in addition to some definite focus of infection, marked nasal blocking by a deflection of the septum or hypertrophy of the middle turbinate. These cases are usually of moderate severity, and there is considerable risk in waiting for spontaneous recovery. Even should this take place, recurrences are common. Owing to the nasal deformity, astringent sprays do not reach the sphenoidal ostium, so that a resection of the septum or turbinectomy, or both, are indicated, in addition to the removal of the infecting focus.

Third—There remains a small number of cases, probably less than 20 per cent, where optic atrophy is to be feared. These are the cases which arise from an especially virulent strain of bacteria, or where, through some anatomic peculiarity, as a small optic canal, the nerve becomes subjected to unusual pressure. Here all one's skill, both in diagnosis and treatment, must be exercised. Procrastination spells failure. In these a definite focus must be sought and eliminated if found, but, above all else, early surgical ventilation of the posterior sinuses is demanded. By this is meant the removal of the middle turbinate and the free opening of the sphenoid and posterior ethmoid cells. The other ethmoids should not be disturbed unless they show definite infection. It is at this point that many rhinologists become unduly alarmed and resort to unnecessary mutilation of the intranasal structures. I do not believe there is any more indication for a complete ethmoid exenteration than there would be for a mastoidectomy in the ordinary case of Bell's palsy, and a bilateral ethmoid and sphenoid exenteration would be as senseless as a radical mastoid for this transitory paralysis.

While I have found several sphenoids with thickening of the nasal mucosa on their anterior wall and considerable edema of the lining membrane, and believe this condition common in cases with optic nerve lesions, I have but one case where I could definitely state that the ostium was closed. This fortunately was in one of our confreres, Dr. J. L. Shipley, of the

Navy. He has written his own history, and it so well describes the symptoms we would expect with negative pressure in the sphenoid that I am giving it as he wrote it four years ago. I made a most thorough examination of the anterior face of the right sphenoid and felt positive that the ostium had been obliterated by scar tissue following a previous opening of that sinus. On removal of the outer wall of the sphenoid, the sinus was found to be filled with a soft mass of tissue, probably edematous mucous membrane. It gave way readily under pressure with a cotton swab. This tissue was not disturbed. The swelling subsided rapidly, and within two weeks was normal. The eye disturbance also rapidly improved. The history was as follows:

"I have been fairly subject to 'colds' most of my life. My nose first required special treatment in November and December, 1908. A physician in Fayetteville, Ark., treated me for two months or more and made four separate cauterizations of turbinates. After this treatment I got along fairly well. However, in 1910, Dr. Moulton of Fort Smith, Ark., made one examination, cauterized one point lightly, and prescribed local treatments—i. e., salt water irrigations, which I used off and on for about two years. I still caught cold easily, and a discharge persisted for a considerable time afterward.

"From 1911 to 1914 I was in England, and all catarrhal symptoms cleared up.

"In 1916, I was troubled with obstructions again, and was treated by Dr. H. W. Loeb of St. Louis. Finally, he performed a submucous resection. One side, I do not remember which, still gave trouble, and Dr. James Smith of St. Louis resected a portion of the soft tissue of the lower turbinate. For several years then I had, as a majority of my patients in the service put it, 'no more trouble with colds and the like than anybody else.'

"I was first troubled with eyestrain in 1910. No error of refraction was found, but as I was using my eyes a great deal for close work, a weak plus sphere was given.

"During the summer of 1918, I was very subject to colds, and the central vision in the left eye became slightly hazy and a small scintillating scotoma was present. Examination

of eyes by Dr. G. B. Trible of Washington, D. C., was negative for pathology; V., O. D. 20/10; V., O. S., 20/30, direct vision; peripheral vision, 20/15. Up to this time, vision in both eyes had been 20/10. After a time scintillation disappeared, leaving a central scotoma which at 20 feet obliterated a 20/20 letter. There was, and is, also slight macropsia.

"About July 19, 1920, while at St. Louis, a sharp attack of iritis developed in left eye; as I remember, there was no antecedent cold or other apparent cause. Vision dropped to counting fingers at 10 feet. There were deposits on Descemet's membrane and temperature of 101° for several days. Physical examination by Dr. Charles H. Nielson was negative, except for chronic constipation found present, due to spastic colon. Spasticity was shown by X-ray plates and fluoroscopic examination. X-rays of teeth, sinuses and mastoids, by Dr. Homer Whelon, were negative. Blood, urine, Wassermann were normal. (National Pathological Laboratory.)

"Repeated nasal examinations by Dr. W. M. C. Bryan showed slight discharge from posterior ethmoids and possibly sphenoids. It is worthy of note that up to this time there had been no mention of sinus infection. Vigorous local nasal treatment was received. Complete dilatation of the iris was finally obtained and recovery was complete and unusually rapid.

"About August 27, 1920, I had a slight cold, but with marked occipital headache. A night or so later I noticed that I could not read the theater program with the lights turned out in the auditorium, as I had been able to do up to that time. Next day there was a slight haze over the central vision of the right eye, V., O. D. 20/15, and perhaps a slight enlargement of the scotoma in the left. I believe there was no scintillation. August 30th, Dr. W. M. C. Bryan exenterated the ethmoids, right and left, and opened both sphenoids. The lining mucosa of both sphenoids, but especially the right, was edematous. This edema and all eye symptoms subsided promptly. Vision in right eye returned to 20/10 in good illumination, though a slight but definite haziness of central vision remained in dim light.

"The operation caused sharp ethmoid and sphenoid headache, and I realized that this was merely an accentuation of a dull feeling between the eyes and at the occiput which I had

had constantly for a long time without being conscious of it. This feeling cleared up, and I then remained essentially free from symptoms for nearly two years.

"During the spring of this year, 1922, the right nostril became obstructed rather frequently, and the right eustachian tube closed up quite occasionally. About March 22, 1922, I had a cold with definite symptoms of sphenoid irritation on the right side—i. e., occipital headache, more on right side, and marked nervousness. A scintillating central scotoma appeared in the right eye. Vision dropped from 20/10 to 20/15. Examination of eye and nose by Dr. Stevenson of Newport, Dr. Richards and associates of Fall River and eye examination by Dr. Verhoeff, were all negative for objective pathology. Dr. White found the right sphenoid to be closed. Forty-eight hours after he opened the sphenoid, on April 22d, all scintillation had disappeared, the right nostril no longer became obstructed, and the right eustachian tube ceased to give trouble. In thirty days V., O. D. was 20/10.

"At present, October 18, 1922, there is a very faint haze over central vision of right eye in dim light. Vision is 20/10 and I am essentially free from nasal symptoms. I still catch cold rather easily, but symptoms are usually mild and respond easily to treatment."

I doubt if it will ever be possible to definitely diagnosticate many cases of negative pressure in the posterior sinuses. The difficulty of accomplishing this is due to their remoteness. The floor of the frontal, the anterior wall of the antrum and the thin orbital plate of the ethmoids, can all be palpated and a tentative diagnosis at least made. The transparent drum membrane permits inspection of the middle ear, but in the sphenoid the most that can be expected is to discover sufficient obstruction or swelling to render this condition possible.

I have in my records about sixty unreported cases with some type of optic nerve disturbance. Thirty-three of these are appended to this paper, as they will be found to substantiate my contention that most cases recover by simply removing the focus of infection. They are numbered from sixty upward, in accordance with my custom of reporting cases in preceding papers along this line. The tonsils appeared to be

the only focus in ten, the teeth in seven, and the antrum in one. Both teeth and tonsils appeared infected in three cases, while in five it was found in teeth, tonsils and antrum. In but three cases were the ethmoids involved, and even in these there was also infected teeth. The posterior sinuses were opened in but five of these cases. A definite focus was found in twenty-nine, while in three it was thought to be systemic, diabetes in one, hyperthyroidism one, postscarlatinal or luetic one. A focus was not discovered in one case. Its surgical elimination was followed by normal vision in fourteen, marked improvement in two, slight in three, none in two. In six, refusal to have it removed was followed by no improvement in five and normal vision in one. Three cases recovered under treatment while one showed marked improvement. A fifth case (the diabetic) did not improve.

Thus teeth and tonsils appeared to be the foci in 70 per cent of these cases, while the ethmoids were involved in less than 10 per cent, so there would seem little excuse for longer considering ethmoids and sphenoids the all important factors in optic nerve disturbances. They rarely require exenteration. The important thing to do in rhinologic surgery, as in all other branches, is to remove the focus.

Case No. 60.—M. G., 9, was referred by Dr. W. F. O'Reilly of Lynn on March 31, 1921, with diagnosis of bilateral optic neuritis.

History: Patient had a severe cold a month ago, and last week her eyes commenced to bother. Could not see well. Pain and sensitiveness on movement and pressure. Still has frequent headaches.

Examination: Turbinates considerably swollen and nose filled with mucopurulent secretion. Very large tonsils and adenoid.

Eye findings: Vision on admission, O. D., 20/60; O. S., 20/80. Questionable pallor on temporal side, both discs.

The tonsils and adenoid seemed so evidently the source of infection that they were removed at once. Dr. Quackenboss examined the case ten days after the operation and found the vision in each eye 20/20. He considered the temporal pallor physiologic and pronounced both fundi normal.

Comment: This was a case with sudden onset of visual disturbance, undoubtedly due to infection from tonsils and adenoid. Recovery was rapid following their removal.

Case No. 61.—M. J. H., 28, was referred from the eye clinic on April 27, 1921, with diagnosis of retrobulbar neuritis right, of one week's duration.

History: Right eye blurry but not lame or sensitive to pressure.

Examination: Nose practically negative—i. e., septum straight; middle turbinate not in contact either with septum or outer wall. No evidence of obstruction to drainage. Both antrums transilluminated normally. The teeth were badly infected. Tonsils apparently not pathologic.

Eye findings: Visual fields showed central scotoma and contraction of periphery. Vision, O. D., fingers at 6 feet; O. S., 20/20.

The case was evidently of dental origin. She was referred to that department of the Massachusetts General Hospital. They reported several molars abscessed and advised extraction.

Comment: The patient refused to have the abscessed teeth removed and so resented being followed up by the Social Service Department that it was impossible to complete her history. The case is reported to emphasize the importance of dental infection.

Case No. 62.—E. S. W., 31, was referred for consultation by Dr. Gordon Berry of Worcester on March 8, 1922, with diagnosis of retrobulbar neuritis, right.

History: Right eye became blurry six months ago and has remained so. Thinks it not as clear as a month ago. Has had occasional colds but not recently. No headache, vertigo or pain about eye. Dr. Berry wrote as follows:

"The diagnosis was uncertain, the X-rays showed nothing, there was no pus at that time escaping from the sinuses nor was there any history of any, and the upper posterior nares showed no edema and only slight congestion. It was, however, a crowded area, and after I had gotten more room by operation the pus began to come. One thing that confused the issue was that a dentist had just removed a diseased tooth with consequent improvement in her vision. The tonsils gave a definite

history of trouble and showed chronic infection, so I removed them and the middle turbinate and then stopped."

Examination: The right side was slightly darker than the left on transillumination. Anterior ethmoids and middle turbinate appear to have been thoroughly removed, but there still remains some obstruction to the posterior sinuses. A small pinhead opening was made out in the front wall of the sphenoid. Through this a probe was passed and soft tissue felt on the floor. Advised Dr. Berry as follows:

"The opening in the sphenoid is small, and it seemed that the floor was soft and in places rough. I would suggest that the front wall be thoroughly taken down. There is considerable turbinate tissue also at the posterior superior angle, and in order to get at the posterior ethmoid cell this should be removed. It is my practice to take out this turbinate tissue and uncap the posterior ethmoid cell. On transillumination there was some difference between the two sides, suggesting posterior ethmoid involvement rather than antrum. While the opening of the posterior sinuses will probably not prove of any immediate benefit to the vision, it will tend to prevent further reinfection. There is, as Dr. Cross well says, considerable pallor of the nerve and a recurrence might destroy it."

Eye findings: Dr. Albert E. Cross of Worcester reported: "She has been under my observation for over fifteen years and up to the present has had no other trouble than a simple refractive error. On September 19th last, she came to me because of loss of vision in the right temporal field and a general blurring of objects ahead. I found her vision 20/200, with effort, and complete loss of vision in the right field in a sector of the right temporal field. Ophthalmoscopic examination was negative except for a questionable paleness of the temporal side of the nerve head; Wassermann negative, blood count normal. In an examination made by Dr. Verhoeff the suggestion of possible pituitary tumor was made, although there were no other symptoms. X-ray examination negative. . . . I then referred her to Dr. Jordan for mental tests, trying to exclude hysteria; his report was negative. During this time there has been some improvement in central vision to 20/50, but a steady loss in the visual field to almost an hemianopsia, and an increasing paleness of the optic nerve. At this time I asked Dr.

Berry to make an exploratory operation to open up the posterior ethmoids. He apparently found no trouble, but two days later found a purulent discharge from this area; with this discharge there was a corresponding improvement in the visual field. Vision steadily improved to 20/30, and the field approached normal in all sectors until she had a secondary infection of the right middle ear and mastoid. Since then the condition has remained stationary with intermittent periods when vision is blurred. Today vision is 20/30 (March 6, 1922), with difficulty, visual field slightly contracted for white but decidedly contracted for color. Nervehead is decidedly whiter than the left, and one begins to wonder if atrophy is not going to take place if the process is not stopped."

Wishing to learn the outcome of the case, I wrote to Dr. Berry, and from his reply, dated February 19, 1926, I quote the following:

"You have her history down to March, 1922. On March 16, her oculist, Dr. Albert E. Cross, found the right eye not quite so well, and a right sided intranasal operation was decided upon and done under ether on March 20, 1922. The anterior ethmoid group had been partly opened November 26, 1921. This operation was confined to the posterior ethmoid and sphenoid on the right. The cells were large. A swollen obstructing superior turbinate was encountered. Most of the posterior cell partitions and the common wall between sphenoid and ethmoid and the anterior face of the sphenoid was removed. There was a large sphenoid cavity with a pterygoid prolongation, also a posterior ethmoid prolongation high to the outside of the sphenoid. There was very little bleeding. I used no postoperative packing. Intense right frontal headaches developed, which were considered due to scabbing damming secretions up into the anterior ethmoid and frontal cells and to scab pressure on the posterior nerves. Things cleared with the cleaning up of the cavity. . . . As to her eyes, I believe they have been absolutely stationary since my ethmoid and sphenoid operation, getting neither better nor worse."

Comment: This case of Dr. Berry's is most interesting, and the fact that she has been under observation so long makes it particularly instructive. The temporal loss of vision suggested some pituitary disturbance, but as yet it has not progressed,

and it is doubtful if it does. The relief following the extraction of an infected tooth and the removal of the tonsils lead us to consider the neuritis as due to foci in the teeth or tonsils. When I saw the case, as I wrote Dr. Berry, the opening of the posterior sinuses would probably not prove of any immediate benefit, as the nerve had been permanently damaged, yet I felt this operation would prevent further loss of vision. His recent letter justified my assumptions. I feel that everything possible has been done for this case and congratulate Dr. Berry on the skillful way he handled it.

Case 63.—R. McL., 32, was seen in consultation for Dr. H. P. Mosher on April 12, 1922, with diagnosis of retrobulbar neuritis, right.

History: Poor general health. Tires easily. Is subject to frequent colds, but does not have tonsillitis. For some years has had excessive amount of nasal secretion. This has been more marked the past few weeks. For past six months has had severe headaches a portion of each day. Has worn glasses for twenty-five years. Five days ago had unusually severe pain about right eye and inability to see the lower half of objects. Vision has grown worse, so that at present only the outline of objects can be recognized. The eye is lame and sensitive to pressure and light.

Examination: Septum fairly straight. Right middle turbinate somewhat obstructive. Crusts in middle meatus right. Tonsils small and do not suggest infection. Several suspicious teeth.

X-ray report: Right anterior ethmoids and right antrum clouded, suggestive of pus. The other sinuses are clear. Sella normal. Several abscessed teeth.

Eye findings: Fundi normal. Vision, O. D., shadows; O. S., 20/20.

Drainage of the infected sinuses and extraction of the abscessed teeth were advised. Dr. Mosher opened the antrum and ethmoids, and Dr. G. H. Wright extracted the teeth. Within forty-eight hours the vision commenced to improve and in two months was normal. There has been no return of the eye trouble, and the general health is somewhat improved.

Comment: Teeth, antrum and anterior ethmoids all showed infection and demanded attention. The recovery was speedy

and permanent. There was no occasion for a more radical exenteration of the sinuses.

Case No. 64.—F. F., 39, was referred by Dr. Edwin E. Jack on September 27, 1922, with question of retrobulbar neuritis, right.

History: The general health had been poor for thirteen years, but especially so for the past two years. Does not have many colds or sore throats. Has been conscious that eyes have not been normal for past three months, and there has been some blurring of the right. Is now unable to read with this eye. No pain or sensitiveness in or about either eye.

Examination: Septum somewhat deflected to right with moderate crowding of right middle turbinate. The right tonsil is large and the crypts contain offensive secretion. Left tonsil small. The teeth do not suggest infection.

X-ray report: Both optic canals oval. All sinuses clear. Teeth show no evidence of apical abscesses.

Eye findings: Vision 20/60 when first taken, but later dropped to 20/80. Fundi negative at first, but later there appeared a small S shaped spot in macula, probably central chorioretinitis.

The tonsils were removed by her family doctor and the right found to be badly infected. The vision improved rapidly. Within a month it was 20/30 but unstable. Two years later the vision with proper correction was 20/20.

Comment: Although at first there was some question as to diagnosis, later developments showed that we were dealing with a chorioretinitis rather than a retrobulbar neuritis. The source of infection was in the tonsils and their removal was followed by complete restoration of vision.

Case No. 65.—G. P., 21, was seen in the eye clinic on September 21, 1923.

Diagnosis: Optic neuritis with edema.

History: Loss of vision of five days' duration following a severe cold.

Nasal examination from the Massachusetts General Hospital was as follows: Nose negative—i. e., no visible pus. Septum very straight, no obstruction. Transillumination of all sinuses quite clear. Tonsils not remarkable. Pharynx slightly reddened.

X-ray showed accessory sinuses negative, sella normal and optic canals 7 by 7 mm.

Wassermann and neurologic examinations negative.

Eye findings: Vision, O. D., 20/40; O. S., fingers 7 feet. The left disc was swollen 2 to 3 diopters; the right normal.

September 24th. Fundus about the same.

September 25th. Three badly abscessed teeth removed. Two dead teeth, not abscessed, were left for the present.

October 2nd. Fields show large central scotoma, left. Considerable enlargement of the blind spot, right. Vision 20/30, O. S. 5/200. Following the extraction of the two dead teeth above mentioned the vision was entirely gone in the left eye for 24 hours.

October 9th. Vision, O. D. 20/30, O. S. 20/60. Nerve head O. S. showed less inflammation.

October 16. Vision, O. D. 20/30, O. S. 20/50.

October 30th. Vision, O. D. 20/30 plus, O. S. 20/20—3.

November 20th. Fundus looks normal; vision, O. U., 20/20—2.

December 21, 1924. Vision, O. U., 20/20; disc O. S. grayish white on temporal half.

Comment: This is one of the prettiest cases of dental infection I have ever seen. The optic neuritis was unilateral and accompanied with a swelling of the fundus of 2 to 3 diopters. The extraction of three abscessed teeth was followed by only slight improvement, while on the removal of the dead teeth the toxins set free caused a total loss of vision for twenty-four hours, which was followed by a very rapid subsidence of the neuritis, so that within a week the vision jumped to 20/60 and within two months to 20/20—2. When seen one year later the vision was normal. Dead teeth, we would infer from this case, may play a great rôle in optic neuritis.

Case No. 66.—N. W. L., 22, was referred by Dr. Eugene Crockett on October 3, 1923, with diagnosis of papillitis, left.

History: Excellent health but rather overworked. Tonsils removed a year ago. Nose feels blocked much of the time, although he rarely has a cold. Eight days ago noticed a line of black dots across page he was reading. The next day there seemed to be a film across the center of the left eye. There

was also some blurring a little to the left and above in this eye. No pain on movement of eye.

Examination: Transillumination negative. There was a ridge on the left side of the septum which was in contact with an hypertrophied middle turbinate. The tonsils had been removed.

X-ray report: "No evidence of pathology in teeth or sinuses. Optic canals normal."

Eye findings: Dr. Alexander Quackenboss followed the eye condition and reported: "Edges of disc gone, white patch side of disc. Patch of exudate side of disc down and out. Numerous hemorrhages over disc itself. Visual fields show enlargement of the blind spot. Vision nearly normal when not obscured by exudate. Diagnosis, papillitis O. S.; right eye normal."

Argyrol and adrenalin spray was prescribed for the nose. The papillitis subsided slowly and within two months the eye was practically normal.

Comment: No definite focus was discovered in this case, and there did not seem to be enough blocking to warrant any intranasal surgery.

Case No. 67.—P. H. S., 66, was referred by Dr. Henry Hawkins on October 26, 1923, with diagnosis of retrobulbar neuritis, right.

History: Rather poor health. Gets tired easily. Has arteriosclerosis. Is not subject to colds or sore throats but has considerable secretion in throat and cough. Three weeks ago noticed a scintillation on the right side of the right eye and found that he could not see objects on that side until they came in front of him. About ten years ago had a similar condition in this eye and has had two or three since then.

Examination: Marked ridge on septum in contact with left inferior turbinate. Right inferior turbinate hypertrophied. The middle turbinates are of moderate size and do not appear to obstruct. Small tonsils. Several suspicious teeth.

X-ray report: "Sinuses show no evidence of pathology. Optic canals normal in size and shape. Pyorrheal pocket surrounds left lower molar with marked evidence of pyorrheal involvement of the remaining teeth."

The patient was treated locally and referred to his dentist for the pyorrheal condition. When seen two weeks later there was a marked improvement in his lateral vision. He died from the arteriosclerosis some four months later.

Comment: In a patient of this age and poor health, only the mildest of treatment was indicated. Any operative procedure might have proved fatal. The teeth were probably the cause of the neuritis.

Case No. 68.—J. M., 64, was referred from the eye clinic on November 7, 1923, with diagnosis of chronic retrobulbar neuritis.

History: Ten months ago noticed a blur in reading signs on the street, first in right eye and later in left. This condition was not benefited by glasses. Occasional colds. Is a moderate smoker. At no time was there pain or lameness in either eye.

Examination: Transillumination negative. Septum deflected to right with compensatory hypertrophy of left middle turbinate. Slight blocking on both sides. Tonsils small, contain some offensive secretion. Uvula and anterior pillars slightly congested and swollen.

Eye findings: Vision, O. D. 20/200, O. S. 10/200.

X-ray report: "All sinuses clear, optic canals normal."

On medical examination the patient was found to be a diabetic and was referred to the Massachusetts General Hospital for insulin treatment. The vision did not improve within the two months he was kept under observation.

Comment: Although the tonsils were suspicious, it did not seem wise to remove them, as it was felt that the neuritis was probably due to the glycosuria.

Case No. 69.—G. H., 29, referred by Dr. J. D. Collins of Northampton on November 27, 1923, with diagnosis of retrobulbar neuritis.

History: Good general health. Has frequent colds. No previous eye trouble. Present trouble started with a cold about two weeks ago. There seemed to be a film over right eye. The eye was lame and sensitive to pressure.

Examination: The septum was deflected to the right, and the right middle turbinate hypertrophied so that there was marked blocking of the posterior sinuses on that side. The left

side of the nose appeared normal. Tonsils were questionable. Teeth appeared normal.

X-ray report: "Frontals, ethmoids and left antrum clear. Right antrum definitely clouded. Sphenoids large and clear. Upper right first molar abscessed. Rest of teeth negative. Sella turcica small but normal. Both optic canals 4.5 mm."

Eye findings: Fundus normal. Color scotoma. Vision 15/80.

Operation: The right antrum was widely opened. The right middle turbinate and tonsils removed. The antrum contained pus and was lined with thickened pyogenic membrane. The tonsils appeared diseased. The abscessed tooth was extracted two weeks later.

Result: The vision improved rapidly. In two weeks it was 15/20. Dr. Ralph Carlton reported five months later as follows: "Vision, O. U. with correction 6/5. Fundi normal; no central color defect."

Comment: This case was about ideal. The focus might have been either tonsils, abscessed teeth or antrum. The surgery done was indicated, irrespective of the eye condition, and recovery was speedy and complete. The exenteration of the posterior sinuses was evidently not indicated. The vision was normal when examined two years after the operation.

Case No. 70.—A. M. B., 59, was referred by Dr. David Wells on November 30, 1923, with diagnosis of bilateral chronic retrobulbar neuritis.

History: General health fair. Is subject to colds and has had considerable thick discharge from the nose for some years. About a year and half ago patient noticed spots before the eyes appearing like veins, then disappeared, but everything seemed to be in a smoke. Vision failed very rapidly and has never returned. The trouble started following a severe cold. The eyes have not been lame or sensitive to pressure but are sensitive to strong light. Polyps had been removed from the right side of the nose and the antrum irrigated. For a time she could not distinguish colors but can at present.

Examination: The right antrum was very dark on transillumination. Both middle turbinates were large and obstructed drainage and ventilation of the posterior sinuses. The tonsils were small and apparently not infected. Most of the teeth have been removed. The remaining ones appear healthy.

X-ray report: "Left frontal sinus very large. Right frontal, ethmoids and antrum clouded. Antrum suggests pus. Optic canals very small."

Eye findings: "The left retina has a very peculiar mottled appearance, which suggests retinal degeneration, but as the patient has a much better vision in dim light it seems to exclude this diagnosis. There is nyctalopia and marked loss of color sensation. The discs appear fairly normal. The visual fields showed marked contraction. Vision, 8/200 right, 6/200 left."

The physical and neurologic examinations were negative.

The right antrum was thoroughly opened. Both middle turbinates were removed, the right ethmoids and sphenoid exenterated. The antrum and ethmoids were badly infected. The sphenoid appeared normal. The middle turbinates were large and cystic. There was some improvement in vision. Two months after operation it was 16/200 in both eyes and was considerably better than that when seen one year later.

Comment: This case was almost hopeless when I first saw her. It was feared by Dr. Wells and Dr. Lancaster, who saw her in consultation, that unless the original focus was removed a second acute attack would destroy her remaining vision. In the two and one-half years since she was operated on there has been no setback. The extensive involvement of the sinuses on the right demanded a much more extensive operation than is usual, but I felt the pathology found warranted it. Had this case been seen early, much better results would have been anticipated.

Case No. 71.—C. B., 35, was referred by Dr. David Wells on December 5, 1923, with diagnosis of bilateral retrobulbar neuritis.

History: Good general health. Had a severe cold last winter, followed by a catarrhal trouble which has never cleared up. Is not subject to sore throats. Left eye became blurry six days ago and has been getting progressively worse since. The right eye began to blur yesterday but not as badly as the left. Eyes not lame or sensitive to pressure.

Examination: Septum deflected to left far back and in firm contact with middle turbinate on that side. Right middle tur-

binate slightly enlarged. Marked blocking left, moderate blocking right. Tonsils suspicious. Pillars congested. Offensive secretion in crypts.

Eye report: "Fundi negative. Vision, O. U., 15/200, central scotoma."

X-ray report: "Sinuses show no evidence of pathology. Sella normal. Right optic canal 5 mm., left 4.5 mm. No evidence of infection can be made out about the roots of teeth and there is no evidence of pyorrhea. Left third molar unerupted."

The tonsils appeared to be the focus in this case but the patient refused to have them removed. Astringent ointments were prescribed for the nose and antiseptic gargles. The neuritis slowly subsided. The vision was nearly normal within five weeks, but a slight color scotoma persisted. Eventually, I have learned, the eyes did become normal and so remained for two years.

Comment: This represents one of many cases that would probably recover spontaneously even if the focus remained. One does not absolutely know that the tonsils were diseased. It might have been an infection from some other region and general eliminative treatment relieved it. One would like to know the future of such cases.

Case No. 72.—A. C., 49, was referred from the eye clinic on January 12, 1924, with diagnosis of bilateral retrobulbar neuritis.

History: Good general health. Rather frequent colds and had one when eye trouble started four months ago. The vision has failed gradually.

Examination: Septum deflected to right, otherwise nose negative. Submerged tonsils. Anterior pillars congested. Cervical gland right. Teeth suspicious.

X-ray report: Sinuses negative. Sella normal. Optic canals 5.5 by 5 mm. Teeth negative.

Eye report: Fundi normal. Central scotoma for all colors except white. Vision, O. D. 20/200, unimproved; O. S., 20/100, unimproved.

Neurologic department reported: "No evidence of pathology in organic nervous system made out. Cranial nerves, reflexes and sensorium seem normal. No ataxia."

Removal of the tonsils was advised. The patient did not return. The Social Service called and reported no special change in the eye condition.

Comment: Tonsillar infection was the only thing found in this case. Its removal should have at least prevented further reinfection, and renewed efforts are being made to get this patient to follow our advice.

Case No. 73.—M. T., 19, was referred from the eye clinic on February 21, 1924, with diagnosis of bilateral retrobulbar neuritis.

History: About six weeks ago, while working in a jewelry factory as a solderer, her vision suddenly became blurry. This was accompanied by frontal headache, dizziness and nausea. Blurred vision lasted 15 or 20 minutes, then passed away and she continued to do her work. Had several transitory attacks, but a week ago the blurriness persisted and her vision was all gone, so that she had to be led home, and has been totally blind ever since. Has pain in her eyes when moving them. When this last attack commenced she had an acute tonsillitis.

Examination: Left antrum dark on transillumination. Septum straight. Diseased tonsils and several suspicious teeth.

X-ray report: "Optic canals 5 by 5 mm., triangular in shape. Upper right molar roots abscessed, also upper left first molar."

Eye findings: "Direct and consensual reflexes all right. Media clear. Fundi and tension normal. Vision, light perception right, nil left."

The tonsils were removed and proved to be badly infected. The abscessed teeth were extracted and the antrum opened intranasally. The vision returned so rapidly after this that the question of hysterical amblyopia was raised. Vision was normal within a week.

Comment: Had the teeth or tonsils not shown definite pathology, hysteria might have been suspected. In this case definite pathology was found and speedy relief followed its removal.

Case No. 74.—E. C., 21, was referred from the eye clinic on March 4, 1924, with diagnosis of optic neuritis, left.

History: Good general health. Has rather frequent colds and sore throats. A month ago, while on way to work, the vision in the right eye suddenly became affected; the upper

portion of objects could not be seen. Four days ago the left eye became red, swollen and painful. The upper lid drooped somewhat and the eye seemed more prominent than usual. No previous eye trouble.

Examination: Marked deflection of septum to left crowding the left middle turbinate. The tonsils were large and appeared infected. Cervical glands enlarged. Teeth negative.

X-ray report: Optic canals 5.5 mm. Sinus negative. Sella normal.

Eye findings: Ptosis left with slight protrusion. Venous engorgement of fundus right, edges of disc hazy. Marked optic neuritis left. Vision, O. D., 20/20; O. S., 20/15.

Neurologic and physical examination negative.

Operation, March 8th: Tonsils were removed. Three days after the operation swelling commenced, at first involving the eyelids on the left but later the right also, thus nearly closing both eyes. A neurologic consultant from the Massachusetts General Hospital reported: "Right eye shows extreme ptosis, chemosis, lacrimation and limitation of movement in all directions. Outline fundus indistinct, disc pale. Left eye, conjunctiva engorged and anesthetic. Eyeball limited in movement and external reaction; pupil medium sized, regular, reacts to light, poorly to accommodation. Disc outline clear, veins engorged, arteries not abnormal, color high. Ptosis, O. U. Right pupil enlarged and fixed. Right conjunctiva anesthetic. Rest of neurologic examination negative. Provisional diagnosis, bilateral infection of cavernous sinus."

The patient did not have the temperature or prostration usually accompanying cavernous sinus thrombosis, and I did not feel apprehensive of the outcome. Under cold compresses the orbital edema rapidly subsided. The eyes resumed their normal mobility, and the patient was discharged within ten days. Later reports showed that there had been no recurrence of the eye condition and that the vision remained normal, as it had been from the first examination.

Comment: This was a most unusual case. Marked infection from the tonsils was the probable cause of the original eye disturbance. The removal of the tonsils exposed large fresh areas for absorption, resulting in the marked edema of the orbital

tissues. The focus having been eliminated, the system rapidly overcame the infection.

Case No. 75.—D. L., 11, was referred from the eye clinic on March 12, 1924, with diagnosis of neuroretinitis, left.

History: Has had trouble with left eye for some months. Tends to look cross eyed. At times has had some pain and lameness about the eye.

Examination: Septum straight, no special blocking by turbinates. Tonsils enlarged and suspicious. Moderate sized adenoid.

X-ray report: "All sinuses and teeth negative. Sella normal. Optic canals 4 by 5 mm."

Eye findings: Left nerve head very blurry, vessels tortuous. Vision, O. D., 20/20; O. S., 20/100.

The tonsils and adenoid were removed March 17, 1924. Within a week the left eye showed marked improvement, and within a month the vision was 20/15 and the fundus clear.

Comment: This case shows how rapidly the eye condition will recuperate when the infecting focus has been removed and how needless it would have been to have done any intranasal work.

Case No. 76.—M. O'F., 19, was referred from the eye clinic on April 1, 1924, with diagnosis of optic atrophy.

History: Defective vision in left eye one and one-half years, worse on temporal side. No colds or sore throats.

Examination: Septum irregular, middle turbinates acutely swollen but not especially obstructive. Tonsils suspicious. Marked congestion about anterior pillars and small glands below angle of jaw.

X-ray report: "Mucous cyst right antrum; all other sinuses clear. Two abscessed teeth. Sella normal. Optic canals 5.5 mm."

Eye findings: Both discs pale, fields contracted, vessels negative. Vision, O. U., 20/200; with correction, 20/40.

Wassermann negative; neurologic examination also negative.

The tonsils and abscessed teeth were removed and the antrum opened intranasally. Four months later the vision was 20/30 plus and the fields normal.

Comment: The results were much better in this case than one would have anticipated from the duration of the neuritis

(one and one-half years) and the pallor of the nerve heads. The tonsils and abscessed teeth were evidently the foci. Removal was followed by most gratifying improvement.

Case No. 77.—L. N. D., 50, was referred by Dr. W. N. Souter on April 3, 1924, with diagnosis of retrobulbar neuritis, left.

History: General health fair. Has frequent sick headaches. Eyes sensitive to light. Had some trouble with her eyes thirty years ago and was told by a Dr. Noyes of New York that she had some optic nerve trouble. Four weeks ago had a severe cold and accompanying it a blurring of the left eye. Constantly bumped into things on her left side. Eyes have felt uncomfortable in the morning for some time . Has had several abscessed teeth removed.

Examination: On transillumination the right antrum was darker than the left. Long septal ridge to left, with enormous engorgement of left middle turbinate, which was tightly wedged between septum and ethmoid wall. The septum was deflected to the right far back and high up. There was also a very large right middle turbinate. Also marked bilateral blocking of the posterior sinuses. Tonsils of moderate size with some congestion of pillars. Teeth suspicious.

Eye findings: Dr. Souter reported "lower half of left visual field lost. Disc margins blurry. This condition has been present for some years. No recent change in fundus, vision 20/30."

X-ray report: "All sinuses clear except right antrum, which is quite dense and suggestive of pus and thickened membrane. Sella normal. Optic canals normal. Cyst about apices of upper right bicuspids and canine, probably the result of infection."

Operation: Septum resected. Both middle turbinates removed. The front wall of the left sphenoid was removed and left posterior ethmoid uncapped. The antrum was opened intranasally and found filled with pus and polypoid tissue. Dr. P. E. Meltzer removed the upper right posterior molar and first bicuspid. A granuloma was found attached to base of the right posterior molar and a cyst to the first bicuspid.

Within a month the blurriness had disappeared from the left eye and vision returned in the lower half of the field. This improvement has been maintained for two years.

Comment: This patient had so much pathology one hardly knew where to begin. The result, however, warranted the effort. The marked blocking of the posterior sinuses made ventilation imperative, otherwise the dental work and the antral drainage would have sufficed.

Case No. 78.—J. B., 25, was referred from the eye clinic on April 26, 1924, with question of bilateral retrobulbar neuritis.

History: Vision in both eyes had been failing for two months. The general health was good.

Examination: There was some hypertrophy of the middle turbinates with moderate blocking of the posterior sinuses. The tonsils appeared diseased and the teeth had several fillings.

X-ray report: "Sinuses negative, sella normal. Optic canals both 5.5 mm. Although advised to have teeth filmed the patient neglected to return."

Eye findings: Fundi negative, central scotoma for green. Vision, O. D., 20/70, unimproved; O. S., 20/70, unimproved.

Neurologic examination negative, Wassermann negative.

The removal of the tonsils was advised, but the patient refused or neglected to return for operation.

Result: The patient returned two years later. The vision had remained at 20/70 in the left eye but had dropped to 20/100 in the right. The fundi were still negative.

Comment: The nerve is now permanently damaged, but further deterioration might be checked by the removal of the tonsils and infected teeth, should such be found on X-ray examination.

Case No. 79.—A. T., 22, was referred from the eye clinic on May 1, 1924, with diagnosis of retrobulbar neuritis, left.

History: Good general health. Tonsils removed about eight years ago. Is not subject to colds or sore throats. For the past two weeks she has noticed a black spot before the left eye and it is lame and sensitive to pressure.

Examination: Slight deflection of septum to right. The left middle turbinate is moderately enlarged but not especially obstructive. Chronic pharyngitis. Some fragments of tonsil tissue remain, but this does not appear to be a focus. Several suspicious teeth.

X-ray report: Sinuses and sella negative. Right optic canal 5 mm., left 4 by 5 mm., flattened on top. Several abscessed teeth.

Eye findings: Fundus negative. Vision, O. D., 20/20; O. S., 20/200.

Neurologic department, Massachusetts General Hospital, reported "bilateral horizontal nystagmus and questionable Babinski, and suggested possibility of cerebral neoplasm."

Following the removal of the abscessed teeth there was considerable improvement in vision.

On March 9, 1926 (about two years later), ophthalmoscopic examination showed "left disc slightly gray, temporal half especially. No central color scotomata. The abscessed teeth evidently caused the neuritis." Vision, O. D., 20/20; O. S., 20/60.

Comment: The possibility of brain tumor was considered in this case, but this was practically ruled out by the fact that vision improved after the extraction of the teeth, and that no further neurologic symptoms developed within two years. Abscessed teeth, therefore, seemed the more probable cause, and their removal was all that was indicated.

Case No. 80.—F. M., 37, was referred from the eye clinic on May 8, 1924, with diagnosis of optic neuritis, right.

History: Vision has been failing rapidly in right eye for ten days and on admission was fingers at 2 feet, O. S., 20/70. Has had no recent cold.

Examination: Septum deflected to right; tonsils small but suspicious; pharynx red.

X-ray report: "Optic canals and sella normal; frontals and antrums clear; both ethmoids, especially the right, clouded but do not contain secretion. Several abscessed teeth."

Eye findings: Fundus right shows hyperemic disc, veins somewhat overfilled. Left fundus negative.

Operation: The septum was resected, tonsils removed and two abscessed teeth extracted.

May 22d. Vision, with correction 20/50 right, 20/70 left.

June 5th: Vision, with correction 20/30 right, 20/70 left.

July 10th: Vision, with correction 20/20 right, 20/70 left.

Comment: This was a favorable case. Definite foci were found in the teeth. The small suspicious tonsils were removed

at the same time and better ventilation obtained by resecting the septum. The removal of the teeth alone might have answered, but the patient lived at a distance, and it seemed best to correct as much as possible at one procedure. The ethmoids, although cloudy, did not seem to require surgical treatment, and as the vision has now remained normal for two years I think we were justified in this conclusion.

Case No. 81.—Dr. C. J. S., 30, was referred by Dr. Oliver Lothrop on May 14, 1924, with diagnosis of retrobulbar neuritis, right.

History: Two months ago had a little rheumatic infection in joints. Two days later noticed a blurring in right eye and a scotoma. The upper and lateral field of vision gone. In rest of field it was about 20/200. The doctor being an eye specialist was able to make these tests on himself. He was confined to bed five weeks. At the end of three weeks the haze in the eye began to clear up, and at present it is but slight; vision 20/20—3.

Examination: Negative nasal examination. There was a tonsil stump on the left side that suggested infection, also two devitalized teeth.

X-ray report: "Right antrum slightly cloudy, indicative of previous infection. Rest of sinuses perfectly clear. The optic canals are 5 by 5 mm., triangular in shape, with increased density at periphery."

There were no changes in the appearance of the fundus. I advised the removal of the tonsil stump (which was done by Dr. Lothrop) and the extraction of the dead teeth, which was done.

This patient wrote me, under date of March 1, 1926, as follows: "I am happy to say that I have regained my normal vision, 20/20 plus, and up to the present have had no return of my previous trouble. I have not had any surgical work done on my nose or sinuses."

Comment: This case was probably largely due to the infection from the teeth, although the tonsil stump might have been a factor also. The results again show how effective is the simple removal of some definite focus and how unnecessary would have been the exenteration of the sinuses.

Case No. 82.—A. C., 40, was referred from the eye clinic on May 14, 1924, with diagnosis of retrobulbar neuritis, right, with papilledema.

History: Good general health. Two weeks ago had severe pain on right side of head, followed four days later by sudden loss of vision in the right eye. At present not even light perception. No previous eye trouble.

Examination: Septum deflected to right. Right middle turbinate enlarged and obstructive. Some secretion in middle meatus. Tonsils suggest infection. Several suspicious teeth.

X-ray report: Sinuses negative. Sella and optic canals normal. One abscessed tooth.

Eye findings: Margins of right disc entirely obscured. Disc reddened and elevated from 2 to 3 diopters. No hemorrhages. Vision nil.

The patient was advised to have the tonsils and abscessed tooth removed, but the vision began to return, and she refused to have anything done. When checked up two years later she reported the vision normal with no recurrences of the neuritis.

Comment: This case was of unusual interest, as with the complete loss of the vision there was a papilledema of 2 to 3 diopters. Recovery was spontaneous. This shows what Nature will frequently do when unaided by surgery. In spite of the recovery, the focus in the teeth at least should have been removed.

Case No. 83.—C. W., 35, was referred from the eye clinic on May 26, 1924, with question of retrobulbar neuritis.

History: General health apparently good. Ten days ago awoke with vision of left eye blurry; within two days the vision in that eye completely failed and has so remained. A year ago the hearing of the right ear was suddenly lost and has never returned. Neither the ear nor eye condition was associated with a cold or any other general condition.

Examination: Septum deflected to left. Slight hypertrophy of both middle turbinates, left touching the septum anteriorly. No marked blocking. Tonsils injected, submerged. No cervical glands. Teeth good.

X-ray report: "Sinuses and sella turcica negative. Optic canals 4.5 by 5.5 mm. Marked increase of density at periphery. Teeth negative."

Eye findings: Both discs are normal and look the same. Pupil O. S. reacts to light and has faint light perception. Pupil reacts when light is held down and in, but in most parts of field no reaction to light. No reaction to light straight ahead. At present there is a feeling of pain O. S. on pressure as compared with the other eye. Ten days later Dr. Verhoeff noted that there was a faint pupillary reaction to light. The fundus was hazy. Vision nil. The pain on pressure had disappeared.

Neurologic department of the Massachusetts General Hospital reported: "Wasserman negative. Nothing found in the neurologic examination to account for the loss of vision, but advised to enter hospital for lumbar puncture and further study."

The patient refused to have a lumbar puncture or any operation and went elsewhere for advice. She ignored several follow up letters from the Social Service Department, but reported on February 24, 1926, in response to a special letter I had sent out. Dr. Verhoeff fortunately was present and was able to compare her present condition with that of twenty-one months ago. He reported "disc O. D. normal, O. S. atrophic." Thinks condition toxic. Patient reported that her house had been painted about the time she lost vision, but could not state whether it was just before or after. Vision, O. D. 20/20, O. S. nil.

Comment.—This case is most unusual, inasmuch as she had total loss of hearing in one ear a year before the loss of vision. The right ear and the left eye. It seemed probable that some constitutional condition must be back of both the deafness and the blindness, hence the desire for study of the spinal fluid, lues or multiple sclerosis being suspected. The eye history is quite typical of a retrobulbar neuritis from some focus; in this case the tonsils seemed the most probable. Infection from the tonsil might also have produced sudden and permanent deafness, although such cases are extremely rare. I am hoping that in time the diagnosis may be cleared up.

Case No. 84.—G. S., 9, referred from the eye clinic on May 26, 1924, with diagnosis of bilateral retrobulbar neuritis following scarlet fever six weeks ago. The vision was reported to have been below normal by the school tests for the past one and one-half years.

Examination: Septum slightly deflected to right with moderate compensatory hypertrophy of the left middle turbinate, so that there is moderate obstruction to both sides of the nose. Tonsils have been removed. Teeth appear good.

X-ray report showed sinuses negative, sella normal, optic canals each 5.5 mm.

Eye findings: Vision, 20/200 O. U. Fundi negative. Central colors questionable.

Neurologic report from the Massachusetts General Hospital was negative, except a strongly positive Wassermann.

September 11, 1924. Vision, O. U. 20/20.

Comment: It was thought at first that the retrobulbar neuritis was due to toxemia following scarlet fever, but in view of the positive Wassermann one is somewhat in doubt as to the etiology. The age of the patient (nine years) leads one to consider the case as congenital, if specific. The rapid recovery was most gratifying. The possibility of the Wassermann being due to the recent exanthemata must also be considered.

Case No. 85.—W. B., 22, was referred from the eye clinic on June 19, 1924, with diagnosis of optic neuritis, left, and descemetitis.

History: Loss of vision of one week's duration. Had a rather severe hemorrhage following a tonsillectomy three weeks ago.

Examination: There appears to be considerable tonsil tissue. The septum was thick and irregular. Some obstruction to posterior sinuses.

X-ray report: "Left first molar abscessed. Slightly thickened membrane both antrums. Sella and optic canals normal. Other sinuses negative."

Eye findings: O. S., edema of nerve head with some exudate and dilatation of veins. Descemet's membrane covered with exudate. Vision, O. D., 20/20; O. S., fingers at one foot.

July 10th. Vision, O. D., 20/20; O. S., fingers at three feet; O. S. cornea clear, no descemetitis now. Vitreous opacities, white patches in fundus.

The report from the neurologic department of the Massachusetts General Hospital was negative.

The report from the male medical department of the Massachusetts General Hospital was "rheumatic fever heart with

mitral involvement. Eye condition possibly result of flareup after tonsillectomy in infection about tonsils."

Dental consultation: "There is a very marked alveolar abscess left superior first molar. The left superior second bicuspid is also abscessed, and the left superior wisdom tooth is unerupted and probably impacted. It is very possible that the teeth have a direct bearing on his eye condition and I advise their removal."

Under ether anesthesia the above mentioned teeth were extracted.

December 11, 1924. Vision, O. S., 6/200; O. S., 20/20.

Comment: The patient was evidently weakened by the tonsillar hemorrhage. With a lower resistance the left eye became infected, probably from the abscessed teeth. The edema of the nerve head was followed by considerable atrophy. This case illustrates the serious sequel of dental infection.

Case No. 86.—T. P., 36, was referred from the eye clinic on July 23, 1924, with diagnosis of retrobulbar neuritis, left.

History: Good general health. Three days ago patient noticed while at work that left eye was blurry. No previous eye trouble and thinks vision in this eye was normal. Vision getting progressively worse. No pain in or about eye. Glands incised in neck seven months ago.

Examination: High deviation of septum to right, with compensatory hypertrophy of left middle turbinate which touches septum. Nose does not appear to show sufficient pathology to account for condition. Tonsils red and injected. Glands both sides. Several gold crowned teeth.

X-ray report: "Frontal sinuses undeveloped, all sinuses clear. Optic canals normal. Teeth: Upper first left bicuspid root abscessed. Upper right first molar root abscessed."

Eye findings: Vision, O. D., 20/20; O. S., 5/200. Both fundi normal.

The teeth were removed and the vision rapidly improved. He was checked up March 31, 1926, when the vision in both eyes was 20/20— and the fundi normal.

Comment: Dental infection was undoubtedly the cause of the neuritis and its removal was followed by recovery.

Case No. 87.—E. W., 54, was referred by Dr. Alexander Quackenboss on August 11, 1924, with diagnosis of optic neu-

ritis, right. As I was absent, the case was handled by my son, whose record is as follows:

History: Good general health. No previous eye trouble. Frequent sore throats and swelling of glands on right side. About two months ago had two abscessed teeth extracted. Septum resected a year ago. The right eye became blurry and painful three weeks ago. Vision failed rapidly, but she thinks it has commenced to improve now.

Examination: High deviation of septum to left. Left middle turbinate in contact with septum. Right middle turbinate markedly hypertrophied and blocks that side. Diseased tonsils. Cervical glands right. Several suspicious teeth.

X-ray report: "Both antrums show a slight thickening of mucous membrane, more marked on right. Rest of sinuses clear and no evidence of retained secretion. Left optic canal 4.5 mm. and right 4 mm. Upper left first molar abscessed. Marked evidence of pyorrhea involving rest of teeth."

Eye report by Dr. Quackenboss: "Patient seen August 11, 1924, when vision right eye was shadows; vision too low to take fields; pupil was normal; pressure on eye caused pain. Optic neuritis; no swelling, edges of disc lost, some exudate and hemorrhage at upper border, retinal veins moderately dilated. Patient seen again September 12, 1924, when vision with glass was practically normal, fields for form and color normal, edges of optic nerve sharply defined, slight pallor temporal half; retinal vessels normal, no hemorrhages or exudates seen. No disturbance of left eye at any time."

Operation, August 15, 1924: Resection of septum. Right middle turbinate removed. Ostium both sphenoids enlarged. Mucous membrane in sphenoids appeared normal. Tonsils removed. Opinion after operation was that removal of tonsils and middle turbinate would have been sufficient. The abscessed tooth was extracted.

Result: Vision improved rapidly. On September 15, 1924, Dr. Quackenboss wrote: "Vision in eye normal. Fields normal. No disturbance of color perception. Optic nerve practically normal" (see above report).

Comment: The small optic canal led my son to open the sphenoids, and while he later thought this not necessary, I am not so sure but that I should have opened at least the right

one, but see no reason for opening the left. I am also skeptical as to the necessity for resecting the septum. The vision returned to normal, which was the important thing, and has so remained.

Case No. 88—G. C. D., 35, was referred from the eye clinic on September 2, 1924, with diagnosis of optic neuritis, right, papilledema left. This case was followed by Dr. Leon E. White, Jr.

History: Good general health. About a year ago had left peritonsillar abscess. Has been losing color vision for a year. No previous operations or injuries. Two weeks previous to first visit to Infirmary (May 23d) vision left eye blurred and four days later that of the right.

Examination: Marked deviation of septum to right. Left middle turbinate enlarged, right middle turbinate touched septum. Tonsils diseased. Foul smelling contents in crypts. Glands below angle of jaw left side. One crowned tooth lower right.

X-ray report: "Sinuses negative. Optic canals normal in size. Sella and skull negative."

Eye findings, May 23, 1924: Vision, O. D., 20/200, with correction 20/20; O. S., 10/200, with correction 20/30 plus 5. Fundi negative.

July 14th. "Vision steadily worse, no headaches, vomiting or dizziness. Disc O. D. blurred nasal side, veins full; papilledema O. S., hyperemic. Diagnosis, optic neuritis O. D., papilledema O. S. Wassermann negative."

July —. Vision O. D. with correction, 20/200; O. S., unimproved, 12 feet.

July 18th. Admitted to hospital.

July 25th. Neurologic report of the Massachusetts General Hospital was negative. "Right disc blurred, papilledema persists. Nasal margins O. D. blurred, obliteration of physiologic cup. Papilledema O. S. with marked distention of small veins. Prescribed potassium iodid. Barany tests normal."

August 4th. Papilledema persists. Readmitted. Vision, O. D., unimproved, 6/200; O. S., 5/200.

September 3d. Vision, O. D., 3/200; O. S., 5/200.

October 2, 1924: No visits since this time. Had several visual fields taken showing gradual loss. In first field, normal

periphery with no central scotoma. Second field, enlargement of blind spot with loss of half temporal field left. Third field, further enlargement of blind spot. Fourth field, only small area vision extending from center out to 20 line and but 20° in width on right side only; a small sector in left. Spinal fluid examination at Massachusetts General Hospital reported negative.

Operation, October 5, 1924: Resection of septum, removal of left middle turbinate and tonsils. Tonsils seemed badly infected. As no improvement followed this operation, the patient was referred to Dr. Gilbert Horrax of the Peter Bent Brigham Hospital, who reported that he could find nothing in his neurologic examination to account for the loss of vision or the papilledema.

March 10, 1926. Vision, fingers 4 feet.

Comment: During the four months that elapsed from the commencement of the neuritis to the removal of the tonsils, the nerves were permanently damaged. Had they been removed early the vision might possibly have been saved.

This was an obscure case and, with the exception of infected tonsils, no focus could be found to account for the papilledema. I saw the case but once and was unable to add anything except that it did not appear to be at all typical of the cases usually classed as optic neuritis. In spite of the negative spinal fluid and the negative neurologic findings, multiple sclerosis seems a possibility. In time some more definite symptoms may develop but the vision seems to be hopelessly gone.

Case No. 89.—F. J. R., 47, was referred from the eye clinic on September 25, 1924, with diagnosis of optic atrophy, left.

History: Fair general health but occasionally dizzy. Uses three packages of cigarettes weekly. No alcohol. There has been gradual loss of vision in the left eye for two years, but never any sudden loss, pain or sensitiveness in this eye.

Examination: Septum deflected to right, marked compensatory hypertrophy of left middle turbinate. Mucous membrane over the anterior wall of left sphenoid appears greatly thickened. Chronic pharyngitis. Tonsils small; contain some offensive secretion. Marked injection of faucial pilllars and soft palate. Several carious teeth.

X-ray report: "Thickened membrane left antrum. Remaining sinuses clear. Sella normal. Left optic canal 4 by 5 mm., right canal 5.5 mm. Four abscessed teeth."

Eye findings: No increased tension. Nerve heads, especially O. S., pale white and quiet. Deep physiologic cup. Few fine vitreous opacities. Pupil left does not react well to light. Vision, O. D., 20/40; O. S., shadows.

Neurologic report: "There is a possibiilty that we are dealing with early tabes. Recommend examination of spinal fluid."

The patient did not return for the above test. The removal of the abscessed teeth was advised, but the Social Service failed to ascertain if this was done.

Comment: The marked dental infection in this case was probably the cause of the atrophy. Its removal should at least prevent involvement of the other eye.

Case No. 90.—E. D. C., 59, was referred by Drs. Alexander Quackenboss and Henry M. Chase on October 20, 1924, with diagnosis of optic neuritis, right.

History: General health very poor. There was albumin in the urine and the blood pressure was high. He was overworked and nervous and has periodic headaches of great severity. Has had a grip cold for the past two weeks. About ten days ago patient noticed a blurring on temporal side of right eye, and within three days the vision became very poor. There was some pain about the eye but no lameness.

Examination: The septum was irregular. The right middle turbinate was crowded between it and the outer wall. The tonsils were small and apparently not a focus. The teeth showed nothing suggestive of infection.

X-ray report: "Both antrums show thickened membrane but no pus. Rest of sinuses clear. Optic canals 4.5 mm., the right irregular. Upper and lower right and left molars unerupted and impacted. No apical abscesses. The antrums show decided pathology."

Eye findings by Dr. Quackenboss: "Vision in right eye about 3/200, a high astigmatic error, edges of optic nerve lost, no swelling made out, retinal vessels tortuous, hemorrhages above and below disc. Optic neuritis. There was some disturbance in field of vision, more down and in than central."

The general condition of this patient was so poor that Dr. Chase, his medical adviser, did not think it wise to give him ether. The antrums were punctured and irrigated. This procedure was not very satisfactory, so about two months later, when the general condition was considerably improved, the right antrum was opened under local anesthesia. The naso-antral wall was very thick and the operation difficult and painful. The general health rapidly improved, and the severe periodic headaches practically ceased, so that on April 6th a general anesthesia was given and the left antrum thoroughly opened and the rather small opening in the right one enlarged. The vision improved somewhat and the disturbance about the disc lessened.

On May 13, 1925, Dr. Quackenboss reported: "I found the vision in the right eye about 1/20 of normal, no improvement with a glass. Optic nerve pale and edges well defined. Optic atrophy. Vision in left eye with glass normal and fundus appears normal."

Comment: The neuritis in this case was thought to be from the antrums. Teeth and tonsils appeared negative. The usual procedure would have been to have opened both antrums under a general anesthesia, but the condition of the kidneys and heart did not at first warrant this. Later, when these sinuses were satisfactorily opened, the damage to the nerve was irreparable. It was hoped that the frequent irrigations of the antrums would benefit the vision but it is doubtful if they did.

Case No. 91.—D. A., 18, was referred by Dr. G. B. Goodall on October 24, 1924 with diagnosis of retrobulbar neuritis, right.

History: Good general health but somewhat hysterical. No previous eye trouble. Had tonsils removed four months ago. Is not subject to colds or sore throats and has not had a cold recently. Ten days ago she noticed a mist before the right eye and it felt sensitive and lame. The vision failed very rapidly, so that she has not been able to see anything with this eye for about a week.

Examination: Septum fairly straight. Middle turbinates slightly enlarged with moderate blocking on the right side. Tonsils have been removed. Pillars not congested and no enlargement of the cervical glands.

X-ray report: "Sella normal, sinuses negative. Teeth show no evidence of infection. Optic canals 5 mm."

Eye findings: "Right fundus shows congestion of the nerve-head. Veins large and tortuous, arteries slightly so. Edges of nerve hazy. Vision nil; left eye normal."

The medical and neurologic examinations were negative.

The tonsils having been removed and the teeth and sinuses negative, I was at first at a loss as to the focus of infection, so studied her for five days, meanwhile using an argyrol and adrenalin spray in the nose. The tonsillar region, which at first seemed negative, was finally found to contain tonsil stumps, so these were removed, and as the vision had been nil for twelve days and aeration of the posterior sinuses seemed urgent, the right middle turbinate was removed, the front wall of the sphenoid taken down and the posterior ethmoid cell uncapped. The tonsils were later examined by Dr. Verhoeff, our pathologist, who reported "atrophic tonsils showing considerable inflammatory reaction."

During the removal of the right tonsil stump pus was evacuated from the supratonsillar fossa. The lining of the sphenoid appeared thickened and congested.

The vision never returned. The nerve gradually turned white and complete atrophy followed.

Comment: The tonsil stumps in this case were doubtless the focus, and the damage was done before they were removed. This shows the danger of delay when there is complete loss of vision. I think I placed too much reliance on the nearly normal size of the optic canal in this case, as up to this time I had not seen optic atrophy following a retrobulbar neuritis in a canal of this size. Then, again, the history of a recent tonsillectomy led me to exclude the tonsils, as on the first two or three examinations they appeared to have been well removed. Whether or not the delay of five days between her first visit and the operation was in a measure responsible for the atrophy, it is impossible to state. It at least emphasizes the danger of delay in any case with complete loss of vision, even with optic canals nearly or quite normal.

Case No. 92.—H. McG., 25, was referred from the eye clinic on October 30, 1924, with exophthalmos and question of retrobulbar neuritis, left.

History: Fair general health. Continuous dull pain in head. Occasional colds, which usually impair the vision. There has been gradual loss of vision in the left eye for about a year and a half and some protrusion of that eye. About a year ago had the left middle turbinate removed and the ethmoids and sphenoid opened. This was followed by some temporary improvement. The eye was less prominent and the vision much better. Within the past two months the eye has commenced to protrude and is now worse than before the operation, and the vision has also been failing somewhat.

Examination: High deviation of septum to right. The left middle turbinate has been partially removed and there is a good sized opening into the sphenoid. The tonsils are hypertrophied and the faucial pillars injected. Small glands at angle of jaw on both sides. Teeth good.

X-ray report: "Slightly thickened membrane both antrums and ethmoids. Sella normal. Optic canals 4.5 mm. and irregular."

Eye findings: O. S., exophthalmos, no limitation of motion, conjunctiva red, tenderness to pressure; accommodation less O. S., pupil reacts, anterior chamber clear; tension not increased. Vision, O. D., 20/15; O. S., 20/30.

Medical consultation reported hyperthyroidism, and a portion of the thyroid was removed at the Massachusetts General Hospital.

The eye condition gradually improved and when checked up on March 31, 1926, vision O. D. 20/20, O. S. 20/15. No exophthalmos. General condition excellent.

Comment: The eye condition was probably due to the hyperthyroidism, which was overlooked when she had the nasal operation shortly after the trouble started. This condition was discovered when we investigated her, otherwise the tonsils would have been removed. As infected tonsils are frequently associated with an overactive thyroid, their removal would probably have benefited the case. Her present excellent condition, however, does not warrant any further surgical procedure.

SUMMARY.

The fact that the opening of the posterior sinuses, although apparently normal, usually relieves optic neuritis, has led to the conclusion that these sinuses are in some mysterious way responsible for the eye condition.

The foci actually responsible for most of the optic nerve disturbances have been found in the teeth and tonsils. The theory of negative pressure in the posterior sinuses would explain the beneficial results which follow the opening of normal sinuses.

Negative pressure is considered under two aspects:

1. Is it possible for it to take place in the posterior sinuses?

2. If it does exist, would this negative pressure favor the passage of the bacteria in the blood stream to the nerve?

Negative pressure is a well recognized condition in the frontal sinus, antrum, anterior ethmoids and middle ear, and is brought about by a closure of their ostia or ducts, so that reasoning by analogy, a similar condition should be brought about by the closure of the sphenoid ostium.

In Bell's palsy negative pressure within the tympanum seems to favor the migration of bacteria from some distant focus to the facial nerve, so that it seems logical to conclude that a similar condition of negative pressure within the sphenoid would favor migration of bacteria to the optic nerve. If it is conceded that a closed sphenoid may favor the invasion of the optic nerve by bacteria from the blood stream, the logical thing is to eliminate the focus that feeds the bacteria to the blood.

Treatment is considered under three heads:

1. About 50 per cent of the cases will recover spontaneously. Any definite focus is to be removed. If none is found, surgical intervention is contraindicated.

2. In 30 per cent of the cases the relief of nasal blocking is indicated in addition to the removal of the focus.

3. In somewhat less than 20 per cent of the cases it will be found necessary to open the posterior sinuses to prevent optic atrophy.

Thirty-three optic nerve cases are analyzed. In but 15 per cent were the sphenoids and posterior ethmoids opened, and

even in some of these it was unnecessary. Postoperative cicatricial obliteration of the sphenoid ostium with resulting negative pressure was found in one case.

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LXXXVIII.

CEREBROSPINAL RHINORRHEA—THE STUDY OF ONE CASE AND REPORTS OF TWENTY OTHERS COLLECTED FROM THE LITERATURE PUBLISHED SINCE NINETEEN HUNDRED.*

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This rare condition, characterized by the escape of cerebrospinal fluid from the nose, has been the subject of many articles during the past twenty-five years. Leber, in 1883, made the first attempt to bring together the records of several cases in order to show that spontaneous cerebrospinal rhinorrhea was a clinical possibility.

In 1899, Sir St. Clair Thomson reported a case which came under his own observation, and with it the reports of twenty other cases from the literature. These were all studied in detail and results of the investigation were published in book form, "The Cerebrospinal Fluid: Its Spontaneous Escape from the Nose," Cassell & Co., London, 1899.

Magendie, in 1842, published his "Recherches sur le Liquide cephalo-rachidien," in order to prove the normal existence of this fluid. Galen speaks of a fluid expressed from several points of the brain into the ventricles, where it is stored and then purged into the nose through the ethmoid bones and infundibulum. While he was mistaken in his belief that this was a physiologic process, it does show the possibility of such a route. In later periods Massa, Vesalius, Vidius-Vidius and Varoli refer to a watery humor of the brain. Schneider pointed out the error in the belief that there was free communication between the nose and the ventricles of the brain.

*Presented as a candidate's thesis to the American Laryngological, Rhinological and Otological Society.

Cotugno (1736-1822) calculated the amount of cerebrospinal fluid at four or five ounces, but was skeptical as to its existence in the living human subject.

The escape of cerebrospinal fluid from the ear was reported as early as 1727, when Stalpartius van der Wiel (Observat rarior cent prior., Obs. XV) published a case in which quantities of a thin clear fluid escaped from the ear for several days after a severe head injury. Langier called attention to the coexistence of a watery discharge and rupture of the tympanic membrane in some cases of fracture of the base.

The character of the fluid, not at first recognized, was established by Nelaton, Robert, Rabourdin, Chatin and Deschamps. Escat (Archiv. internat. de Laryngologie, 10, No. 6, 1897) published a report of a case in which there was a spontaneous escape of cerebrospinal fluid from the ear, and this was the first case to attract Thomson's interest in the subject. The patient was a girl, ten years of age, in whom the escape of fluid from the ear began without apparent cause. Chemical examination of the fluid proved it to be identical with that of cerbrospinal fluid. Examination of the ear showed in the inner third on the upper wall a fine white line. Although suction failed to draw any fluid from it, Escat decided that this indicated the point of escape, and he applied the galvanocautery, with the result that the flow ceased and had not recurred two months later. He regarded this case as one of congenital defect.

The escape of fluid from the nose following injury has not been so frequently observed. Bidloo, a medical writer who lived in the second half of the sevententh century, reports a case of a patient who had an accidental injury of the bridge of the nose, followed by a flow of watery secretion from the right nostril. Blandin, in 1840, was of the opinion that he was first to note an enormous serous flow from the nose in certain cases after injury.

The discharge of cerebrospinal fluid from the nose following a fracture of the base may be a very important symptom, and sometimes the only one noted, as in a case reported by Vieusse in 1879.

In referring to the standard textbooks on medicine and also those on special subjects, Thomson was unable to find any

mention of the spontaneous escape of cerebrospinal fluid from the nose. At the present time there is very little to be found in the standard textbooks on this subject. In "A Treatise on Diseases of the Nose and Throat," by F. H. Bosworth, 1889, ch. XV, p. 258-271, he describes nasal hydrorrhea at length. The origin of the fluid does not seem to have been recognized, as he groups under this heading all of the conditions which might cause a watery discharge from the nose, as nervous coryza, polypi in the antrum, etc. He ascribes the condition as being due to loss of vasomotor control of the blood vessels in the nasal mucous membrane, causing an abnormal exosmosis.

PATHOLOGY.

Autopsies have supplied the following data: The existence of a passage of communication between brain and nose, past the decayed ethmoid (Güntz). In the case of Mermod there was a small opening behind the crista galli apophysis. Signs of infection have been found and Baxter indicated thickening of the bones of the cranium. In four cases there were signs of chronic hydrocephalus. In four instances there were encephalic tumors. In the case reported by Harmon Smith, death resulted from meningitis, and postmortem revealed a fracture of the base of the frontal bone with a fissure, which upon prolongation to the ethmoids permitted the passage of a thin probe between the frontal lobes. In Niccioli's patient there was a revolver bullet lodged in the right sphenoid fossa, and a fissure in the bone which extended to the corresponding nasal fossa.

Olmos and Lizondo, whose case report is a part of this paper, found at autopsy a healed wound of the frontal bone 2 to 3 mm. in diameter. The posterior wall of the frontal sinus was seen to have been opened for 5 to 6 mm. transversely and 4 mm. vertically. There was an aperture in the dura that continued into the mass of the encephalon, through which a sound could be readily passed. Vertical section of the encephalon showed, 3 cm. from the anterior pole of the frontal lobe, a new formed cavity in the white substance, communicating internally with the anterior horn of the right lateral ventricle, and externally with opening in the dura and frontal sinus. The walls of the latter were of a light chocolate color,

evidently due to hemorrhage. The authors think that the trauma caused a hematoma which kept the walls of the new formed cavity separated; this led to a chronic inflammatory process and adhesions. Increase of tension of the cerebrospinal fluid caused by heavy drinking at the time of the accident also played a part. The case might have been susceptible of cure by prompt surgical intervention.

Nothergel's case showed a small hard tumor of the brain, occlusion of the Sylvius aqueduct, a cavity 15 mm. deep. The perforated lamina was thin and contained deep holes.

Wollenberg found in his case cerebral tumors and holes 2½ mm. in diameter on each side of the crista galli apophysis, establishing a communication between the cranium and the ethmoid labyrinth. The frontal lobes were adherent to the subjacent bones, and perforations placed the anterior end of the lateral ventricle in direct communication with holes in the perforated lamina.

Vigoroux found at autopsy a voluminous papilloma of the choroid plexus of the fourth ventricle, considerable enlargement of the holes of the perforated lamina communicating with the nasal fossæ, enormous dilatation of the pituitary fossa, marked dilatation of the lateral ventricles, of the Sylvius aqueduct and of the third ventricle, and finally an adhesion of the lower surface of the frontal lobes on each side of the crista galli apophysis.

Thomson suggests the possibility of a small congenital opening in which the dura becomes entangled and forms a meningocele, the rupture of which would allow the cerebrospinal fluid to escape. I have found on record one such case, in which a supposed polypoid growth was removed from the nose, and following its removal there was an escape of cerebrospinal fluid from the nose. Microscopic examination of the removed growth showed it to be a meningocele.

In none of the twenty cases reported do I find any mention made of the possibility of this fluid escaping through the craniopharyngeal canal. Remnants of this structure are found normally in some lower animals and can be demonstrated in the human at term. There is sometimes seen a depression in the mucous membrane on the inferior surface of the sphenoid

bone which marks the place where this canal has opened. Cushing operated on a patient for pituitary disease and a cerebrospinal rhinorrhea resulted. On the ninth day after operation the patient had a severe sneezing spell, then developed a meningitis and died on the thirteenth day. At autopsy a persistent craniopharyngeal canal was found which had been opened at the time of operation.

The radiogram in his case showed an unusually small sphenoid sinus and unusually large ethmoid cells. Examination of the case here reported revealed a mass about 1 cm. in diameter in the region of the pharyngeal tonsil. This mass was continually in an irritated condition, apparently from the fluid which escaped at some point near its attachment. I feel that the persistent craniopharyngeal canal is the most probable route of exit for the fluid in this patient.

PATHOGENESIS.

Many theories have been advanced to account for the flow of cerebrospinal fluid from the nose; the majority of them have not been confirmed at autopsy. One incomplete history of an intranasal meningocele is here recorded.

Trauma, necrosis of the ethmoid, pressure necrosis due to tumor of the hypophysis, dehiscence in the lateral walls of the sphenoid, holes in the perforated plate which are deprived of nerve fibers, lymph passages starting from the arachnoid spaces and opening on the surface of the nasal mucous membrane, and lastly, along the perineural sheaths. The abnormal routes lack anatomic confirmation, and it would seem that the natural ones only were possible. Under normal conditions of pressure all of these natural routes are impermeable to the cerebrospinal fluid, but it does succeed in penetrating these when there is an increase in pressure. This increase in pressure will be found in all patients with cerebrospinal rhinorrhea, and it is usually associated with one of three processes: 1, Reduction of the cranial capacity. 2, Increase in volume of the brain. 3, Overproduction of fluid. It can be said that generally the cerebrospinal rhinorrhea follows directly upon a condition of hydrocephalus, by which term is understood a pathologic condition in which the proportion of cerebrospinal fluid is in excess of the normal amount.

It appears to be established that the organs which produce the cerebrospinal fluid are the choroid plexuses, and, according to some physiologists, also the ependymal cells. It is not definitely known whether the process is merely one of transudation, as is held by Milian and Mestrezat, or one of regular secretion, as most authors hold today. (The cerbrospinal fluid does not contain the normal complement and amboceptor, or the defensive Abderhalden ferments, as do the transudates.) It is evident that in the physiologic case the choroid plexuses must be sensitive to the hydrostatic pressure, since the absence or excess of secretion would determine the cerebromedullary pressure. It has been determined that the total amount of cerebrospinal fluid present in an adult is about 150 cc., and its circulation, as proven experimentally, is very slow, discharging probably in the lymphatic and perivascular venous system through the lymphatic sheaths (Cathelin), through the granulations of Paccioni (Key, Retzius, Schwalbe) and through the arachnoid sheaths of the nerves. When the subarachnoid space is accidentally opened allowing its fluid to escape when the hydraulic pressure is lowered, the choroid plexuses become excited and exert themselves to establish the equilibrium, and under these conditions they can attain enormous functional capacity. (The cephalic fluid possesses greater tension than does the blood which circulates through the cerebral venous sinuses, allowing transudation through the granulations of Paccioni.)

Possibly, in addition to the choroid plexuses the other meninges are involved in cases of such hypersecretion, and we are here concerned with a regular transudation.

The choroid plexuses can be stimulated, either indirectly through the circulation, or directly, that is, through lesions originating in situ. Ether, pilocarpin, muscarin, augment the secretion of the fluid, and a small injection of Chinese ink in the primitive carotid, after previous ligature of the external, causes the plexuses to become impregnated, the immediate effect of which is to cause intense hypersecretion (Milian, Cathelin). Whether the lesion be syphilis, tuberculosis, neoplastic or inflammatory, when it settles in the choroid plexuses, it produces the same results, as has been shown in the case of Vigoroux (papilloma of the choroid plexuses).

Serous meningitis causes a considerable hypertension, starting either a general or an internal hydrocephalus, when the communication between the ventricles and the rest of the subarachnoid space has been shut off. This persistent increase in tension may result in irreparable injury to the visual apparatus. This symptom very often accompanies or precedes the escape of cerebrospinal fluid from the nose. (Edema of the papilla or a well developed optic atrophy.)

Weed concludes that the chief method of return of the fluid to the general circulation is filtration through the arachnoid villi, and an accessory drainage into the lymphatic system.

The writer feels that in the case here reported influenza was a factor in bringing on conditions which resulted in the escape of cerebrospinal fluid from the nose. The most important of these is an increase in the tension of the cerebrospinal fluid. This might be due to a serous meningitis or an interference with the normal exit of the fluid.

Negative pressure, as used by many rhinologists today in the treatment of sinus disease, might, in the presence of an increase in the tension of the cerebrospinal fluid, be partly responsible in the production of an abnormal route of exit into the nasal fossæ. This method of treatment had never been used in treating the case reported.

DIAGNOSIS.

The diagnosis is usually easy to establish. The differentiation of nasal hydrorrhea is based on the examination of the secretions. In true nasal hydrorrhea the flow takes place almost always from both nostrils, although sometimes more from one side than the other and ceases during sleep. As a rule, it is preceded or accompanied by other signs of irritation, as sneezing, lacrimation and photophobia. The flow is variable and seldom has regularity in either the dripping or the intermissions; it is seldom continuous for more than a few hours or a few days at a time. Headache is not usually relieved by the flow. Cerebral symptoms are not marked, and ocular symptoms in connection with it are unknown, except for some conjunctival irritation. The analysis of the fluid may generally be relied upon to settle the diagnosis in doubtful cases.

Due consideration must be given to differentiation of cerebrospinal rhinorrhea from a watery discharge originating in the maxillary antrum. There is always the possibility of a combination of symptoms due to the presence of conditions in the nose and accessory sinuses, in cases where a true cerebrospinal rhinorrhea also exists.

The final test is the finding of a copper reducing substance in the fluid, and most investigators now agree that this substance is glucose. Halliburton, Mestrezat and many others thought that it was pyrocatechin. The presence or absence of albumin or chlorids is not of diagnostic value, but it is important to determine whether or not mucin is present.

Radiography is of little value in determining the presence of abnormal openings in the cranium.

Where a positive diagnosis cannot be made, the procedure of Constantin might be resorted to: injection by means of lumbar puncture of 1 c. c. of a solution of fluorescin to determine the outflow of this fluid through the nostril. The escape of cerebrospinal fluid may continue over a period of years without exerting any appreciable effect on the functions of the central nervous system. Ear symptoms have not been observed often (twice). Long continued discharge of the fluid from the nose may give rise to mucous polypi. Eye symptoms are frequently observed, optic neuritis which passes into atrophy or a postpapillitic atrophy. In the cases of Leber and Nothnagel there was atrophy of the olfactory nerves; usually they are unimpaired.

In a large majority of cases the escape of fluid is from the left side of the nose. On examination, the fluid can be seen coming down between the middle turbinate and the septum, at which point it seems to collect when the patient holds the head erect; if the head is then allowed to drop forward, about 1 c. c. of fluid will escape at once. When lying down, the fluid passes back into the throat and is swallowed during sleep. The swallowing of this fluid will sometimes cause nausea and vomiting.

A fluid which always escapes from the same nostril continues to flow day and night for many days; on drying does not stiffen linen; disappears and reappears suddenly, the onset

not preceded by any subjective symptoms in the nasal fossa, has every probability of being cerebrospinal fluid.

The amount of fluid discharged during twenty-four hours varies considerably in different cases and also varies in a single patient. In the author's case the intake of fluid seemed to have considerable influence on the amount which escaped through the nose. If large amounts of fluids were taken, there was an increase in the amount of cerebrospinal fluid which escaped from the nose. The usual amount of fluid collected has been from seven to sixteen ounces in twenty-four hours. Some observers have reported as high as 2,000 cc. per day.

THE CEREBROSPINAL FLUID.

The existence of cerebrospinal fluid was known to Hippocrates (460-370 B. C.), who is credited with having tapped the ventricles in hydrocephalus. The presence of such a fluid in normal persons, however, was recognized by him. In 1784 Contugni made the discovery of cerebrospinal fluid in living fishes and turtles, but did not mention its presence in man. Magendie, in 1825, gave an accurate description of the circulation of the fluid, especially at the base of the brain. He also described the physical appearance and protective function of the fluid. In the early periods a complete analysis of the cerebrospinal fluid was impractical, owing to the difficulty in obtaining the fluid. Morton and Wynter, in 1889-1891, reported a series of spinal punctures, but for the simplification and perfection of this procedure we must give credit to Quincke.

The cerebrospinal fluid may be defined as a selective filtrate, as no new substance is formed. The origin of this fluid is a point upon which authorities do not all agree. The most probable source is from the choroid plexuses, located in the ventricles. It is absorbed into the venous sinuses of the brain through the arachnoid villi and to a less extent by way of the lymphatics.

The normal amount of fluid is about 120 c. c., and the amount formed in 24 hours is reported as being from 600 to 700 c. c.

Pressure.—Quincke gives 40 to 60 mm. of water as the normal pressure in children and 150 mm. in adults. Other observers give as high as 300 mm. when taken in the prone

position. Myers found the pressure in some cases of dementia paralytica to range from 60 to 385 mm. at the beginning of the puncture and 10 to 120 mm. after the fluid had been removed. The normal pressure is influenced by many factors. As a general rule, it varies from 45 to 90 mm. of water in children and 130 to 150 mm. in adults.

The specific gravity of the normal fluid varies from 1.001 to 1.008. One observer gives the normal as 1.012.

Chemical Composition.—Halliburton was one of the first to study the composition of the cerebrospinal fluid, and recent observers have added many new facts in this connection. Total solids vary from 1.200 to 0.876 gms. per 100 cc. Inorganic matter: sodium oxid, potassium oxid, magnesium oxid, calcium oxid and iron oxid, nitrates, sulphates, phosphates and chlorids. The chlorids are found in the largest amounts, 0.728 to 0.740 gms. per 100 cc. Protein varies from 0.02 to 0.07 gms. per 100 cc.

Myers' investigation as to the potassium content is of interest; he found the normal content to be 1.7 to 3.4 mgms. per 100 cc. There was a marked increase in the potassium content if the fluid was removed after death; in one case the amount per 100 cc. was 12.0 mgm. In 17 cases where the fluid was removed from one-half hour to 15 hours after death the potassium content ranged from 7 to 12.7 mgms. per 100 cc.

He also found that all the fluids gave a trace of reduction with Benedict's solution during life, but, postmortem, this was not always observed.

As early as 1852 a copper reducing substance was found in the cerebrospinal fluid. Halliburton and others thought this to be pyrocatechin, but Halliburton now admits that it is dextrose. The amount of sugar found by various authors is from 0.032 to 0.148 gms. per 100 cc. Sugar in the cerebrospinal fluid is found in amounts somewhat lower than that found in the blood. In a series of cases, Myers found that the amount of sugar in the cerebrospinal fluid was 60 per cent of that found in the blood. In a diabetic with a blood sugar of 0.438 he found the concentration in the cerebrospinal fluid to be 0.30.

Total nitrogen varies between 0.0218 and 0.0464 gms. per 100 cc.; nonprotein nitrogen, 0.0126 to 0.0388 gms. per 100

cc.; urea nitrogen, 0.006 to 0.020 gms. per 100 cc. In a series of 15 cases, Myers found the urea in the cerebrospinal fluid was 88 per cent of that found in the blood. Creatinin was 46 per cent of that found in the blood. Uric acid does not readily pass into the cerebrospinal fluid and the amount found was only 5 per cent of that in the blood.

The normal reaction of cerebrospinal fluid is faintly alkalin or neutral to litmus, but when tested with phenolphthalein gives an acid reaction. The fluid becomes more alkalin on standing, especially if it is kept in an unstoppered container.

Various authors give the number of cells in the cerebrospinal fluid to be from 1 to 20 per cc.

The following reports of twenty cases have been recorded since the publication of Sir St. Clair Thomson's book, "The Cerebrospinal Fluid, Its Spontaneous Escape from the Nose," Cassell & Co., London, 1899:

Glynn, T. R., and Glynn, E. E. A case simulating intracranial tumor, spontaneous and persistent escape of cerebrospinal fluid from the nose, with complete recovery. Tr. Med. Soc. Lond., 1905, XXVIII, 303-6.

Man, aged 26. Family and personal history good. Seven years previously he had received a blow on vertex of head, causing unconsciousness, headache and vomiting. After a month, headache became paroxysmal and was associated with vomiting and dilatation of pupils. Double vision and general neuropathic symptoms.

In 1903 had several epileptic attacks and incontinence of urine. About this time clear fluid commenced to flow from right nostril and very soon improvement set in, followed in a few weeks by complete recovery, except for a slight failure of memory and lack of energy, which disappeared after six months. Fluid secreted stated to be cerebrospinal.

Dr. Glynn, Jr., showed diagrams illustrating case. First one showed the circulation of the cerebrospinal fluid in the normal individual as far as was known. The fluid secreted by the choroid plexuses of the lateral ventricles passed into the third ventricle, thence into the fourth, and then out through the foramen of Magendie, and probably through two other less important adjacent foramina into the subarachnoid space; from

there, via the perineural and perivascular lymphatics, into the venous circulation. According to Cushing, the subarachnoid fluid also escaped directly into the superior longitudinal sinus. In the case described, it was considered that chronic inflammation at the base of the brain in the vicinity of the fourth ventricle blocked up the foramen of Magendie, and that, therefore, the fluid accumulated in the third, fourth and lateral ventricles, and that the lateral or third ventricle had distended so much that they had ruptured in the thinnest place. The fluid had not escaped into the general subarachnoid space, but, owing to adhesions, passed straight into the prolongations of the arachnoid which covered the olfactory nerves, and so into the nose.

In the discussion, Sir St. Clair Thomson said that this case, fully recorded by Dr. Glynn, was a very valuable addition to the subject, on which there were very scanty observations in the English literature. As far as he knew, the present was the third case which had been put on record in English reports of authenticated cases of cerebrospinal rhinorrhea (his own, 1896, and Dr. Watson Williams', 1901). It was very satisfactory to find that the present case had been so fully observed before the cerebrospinal rhinorrhea had developed, because it helped to confirm the working hypothesis which he threw out nine years previously, viz., that it was due to hydrocephalus internus. He thought Dr. Glynn's theory of how the fluid escaped was very plausible.

Case of cerebrospinal rhinorrhea, which had apparently recovered spontaneously. Watson Williams: J. Laryngol., Rhinol. and Otol., 20:324, 1905.

This woman, aged 43 years, was shown in the Laryngological Section at the annual meeting of the British Medical Association, and was reported in the British Medical Journal, Vol. 2, page 1042, 1901. The patient had good health until 1901, when she had a febrile attack resembling influenza, but with constant dripping of cerebrospinal fluid from right nostril. She lost a pint of fluid daily during waking hours, and more which ran down the throat posteriorly during the night. The escape of fluid persisted until about three months ago, when it began to lessen, and it ceased about a month ago. The patient was subject to severe frontal headaches, from which she had

suffered for many years. She seemed fairly normal at the time of writing.

(In the report of this case in the British Medical Journal it is stated that the patient bumped her head violently in 1900.)

Rhinorrhea cerebrospinalis. De la Camp: Berliner klin. Wchnschr., 41: 72, 1904.

In August, 1896, a woman fell, striking the back of her head; the pain was over in a few days. The following winter she had slight symptoms of a "cold," accompanied by vomiting. One year later she fell a second time, this time from vertigo. Vomiting and headache became more frequent, and she began to suffer from poor eyesight, especially on the right side; the sense of smell was diminished, and choked disc developed on both sides, with beginning atrophy. There were disturbances in the right trigeminus, facial, acusticus and hypoglossus. Two special features marked the further course of the disease: (1) the inconstancy of any given nervous symptom, the disturbances being in one nerve, now in another; (2) the variability of the attacks, there being now dizziness, now loss of consciousness, now convulsions in different parts of the body, with slow pulse. In the sixth year (1902) after the fall, an intensive "cold" appeared, after an unusually severe series of attacks. Drops of clear, transparent fluid began to drip from the left nostril whenever the patient bent her head forward, or ran down her throat when she was recumbent. A 24 hour amount of 180 cc. escaped in this way. The fluid did not stiffen when drying on a handkerchief; addition of acetic acid caused no precipitate; there was 0.05 per cent of a reducing, fermenting, dextrorotatory substance in it, which formed phenylglucosazone crystals; also 0.05 per cent of a substance composed almost wholly of globulin-albumin and of an inorganic ash outweighing the organic by four times.

Spontaneous rhinorrhea cerebrospinalis is due, in order of frequency, to (1) cerebral tumor, (2) hydrocephalus, and (3) probably congenital cranial anomalies. The left nostril is the one generally affected. In the present case the left sidedness of the affection was due possibly to a tumor lying in a central cranial fossa, or possibly to the form of extension of the

glioma, which apparently spread to both hemispheres. The inconstancy of the symptoms naturally makes it impossible to locate it with exactitude. There may have been a fracture involving the ethmoid, at the time of the fall. Cysticercus cyst was excluded by spinal puncture.

Kinsman, D. N.: Cerebrospinal rhinorrhea. Jour. Am. Med. Assn., 1908, 1, 1791.

Woman, aged 44, presented typical case of spontaneous escape of cerebrospinal fluid from the nose. No indications of optic or cerebral involvement. This patient was lost sight of, but at the last report, six months after consultation, the flow was still continuing.

One case of cerebrospinal rhinorrhea and two cases of nasal hydrorrhea. John H. Phillip and Philip King Brown: Tr. Med. Soc. Calif., San Fran., 30:474, 1900.

A woman, aged 25, came under observation in July, 1898. When a child, before the days of cocain, some cutting had been done. The discharge was unbearable, occurring at most inopportune times. The flow was first noted in October, 1897, and continued, off and on, sometimes from one nostril and sometimes from the other, but never from both during the same attack. Severe sneezing followed the attacks, which began on waking and lasted two or three hours. Then it would stop for about an hour and begin again later in the day. Patient's general health was excellent. She was more athletic than the average young woman.

In this patient the attacks ceased suddenly and absolutely three months before the time of writing. It was impossible during the flow to determine at what point the fluid made its exit into the nose. Of the various therapeutic measures employed, atropin alone seemed to give relief.

Cases of nasal hydrorrhea not included here.

Freudenthal, W. Spontaneous Flow of Cerebrospinal Fluid from the Nose: Arch. f. path. Anat., Berl., 1900, CLXI, 328-337. Abstracted in New Yorker med. Wchnschr., 1900, XII, 364-6.

Female patient, aged 50, in October, 1900, presented high fever, followed by such a severe headache that patient thought she would lose her mind. All remedies proved unavailing. Pain stopped after some months, and dripping from the nose

set in which lasted a whole year, followed by intermission and headache. Eyesight and hearing became worse and general apathy set in. When author saw the patient the dripping was continuous, in all positions and at night. No abnormal symptoms in nose. Had two polypi on successive occasions after flow had begun.

Diagnosed as pressure caused by something in brain, assumed to be a tumor. Many symptoms indicated that the liquid was cerebrospinal fluid, which probably issued from some slight perforation in the horizontal plate. Author bases his conclusions on St. Clair Thomson's work.

Dr. Jos. Fränkel, in the discussion, considered the diagnostic conclusions somewhat unwarranted, and thought the symptoms insufficient to assume the presence of tumor. If one could have assumed that a tumor existed in the vicinity of the third ventricle, where it would necessarily have led to obstruction of the cerebrospinal fluid, the flow would have increased as time went on, and additional localized phenomena would have appeared. No case has been recorded in which the only symptom was discharge of cerebrospinal fluid and in which a cerebral tumor was found. A tumor of the hypophysis would show more optic disturbances than existed in this case.

Watson Williams. Notes, Specimen and Drawing of Case of Cerebrospinal Rhinorrhea, with Subsequent Ethmoiditis, Mucocele and Frontal Sinus Suppuration, Indistinguishable from Ethmoidal Mucocele; Operation; Death: Proc. Roy. Soc. Med., London, 1913-14, VII, Larngol. Sec. 6-10.

This case is a very rare instance of cerebrospinal rhinorrhea, complicated by an intercurrent pansinusitis, which affords an example of an unforeseen contingency which led to a fatal result following a frontal sinus operation. The cerebrospinal rhinorrhea was diagnosed by inference, but the author feels that the evidence for its existence is sufficiently complete to make it a fair presumption.

A man, aged 42, had complained of double vision for about four months, but for nearly five years had stated that sight was "curious." For two years was likely to walk sideways, and for about two years had noticed a swelling in upper internal angle of right orbit. Had suffered from recurrent headache for

many years, but much more severely for the previous two weeks, chiefly vertical, and once, a day or two before admission, he had vomited.

Both nasal passages were completely occluded by edematous polypi, but there was no purulent discharge. Right eye displaced downwards and outwards; definite exophthalmos and movements somewhat restricted. Pupils react normally. Swelling at inner angle of orbit was soft and fluctuating. On day of admission to hospital there was a copious clear watery discharge from nose for about an hour and a half, and the orbital swelling almost disappeared. Patient stated that this had occurred on several previous occasions.

Optic symptoms and headache very much decreased, but returned.

Diagnosed as nasal polypus with consequent occlusion of ethmoid cells, and as a result of distension an ethmoid mucocele was supposed to have arisen, emptying itself at intervals, the other bony wall being absorbed. There were none of the usual signs suggestive of frontal sinus suppuration.

Operation under general anesthesia. Maxillary antra were first explored; mucopus withdrawn from both. Polypi removed and a double intranasal antral operation performed, numerous large polypi being removed from the antral cavities, whereat the external orbital swelling collapsed. Next, a curved incision was made down to the periosteum, which was raised from the bone. A gush of pus followed, and a fistulous opening in the floor of the frontal sinus was found. Frontal sinuses were thrown into one by a Killian operation on right side, the frontonasal passage was enlarged and left frontoethmoid cells of frontal septum removed. Dura mater was found exposed by a dehiscence of bone over an area of about three-quarters by one-half inch.

Patient at first rallied after operation, but became rapidly worse four days later and died of acute meningitis, obviously due to infection through a very small anatomic communication through the dura mater exposed at the time of the operation. This suggested previous cerebrospinal rhinorrhea, which was confirmed by inquiry. Author supposed that owing to development of antral suppuration with subsequent formation of nasal polypus and also frontal sinus suppuration, the escape

of cerebrospinal fluid from the ostium in the dura mater down the nasal passage became obstructed by the growing polypus. Consequently, it formed an external swelling with bulbar displacement, with occasional eruptions of cerebrospinal fluid through the nose. If he had suspected cerebrospinal rhinorrhea, the author would not have operated.

Schwab, S. I., and Green, J. A Case of Cerebrospinal Rhinorrhea, With Retinal Changes: Am. Jour. Med. Sci., Phila. and N. Y., 1905, N. S. CXXIX, 774-81.

A woman, aged 32, presented continuous watery discharge from right nostril. Neuropathic family history; poor health. Four years previously suddenly attacked by paralysis of left leg; stiff and weak but not painful; recovered fully. Nasal trouble commenced two years ago, following a cold. Flow increases with nervous worry. Fluid is clear, tasteless and does not stain or stiffen linen. No pain other than occasional headaches, which, however, are uninfluenced by amount of discharge. Six years ago patient had attack of "pink eye," from which she promptly recovered under treatment. In 1899 haziness of vision set in, accompanied by symptoms of asthenopia.

Nasal dropping did not appear until four years after onset of neuroretinitis. Greatest degree of atrophy is found in nerve on side opposite the dripping nostril. In both respects the case offers a contrast to the majority of the cases in the table.

The feature in which the present case differs conspicuously from the clinical picture of hitherto recorded cases of cerebrospinal rhinorrhea consists in the reservation of a high and almost equal degree of visual acuity in both eyes, despite indubitable evidence of inflammatory and atrophic changes in both optic discs. It should be borne in mind, therefore, that while the type of optic neuritis in this disease is usually severe and greatly destructive of sight, a much milder form (Baxter, Nettleship and the present case), running a typical inflammatory course without seriously impairing the fibers of the nerve, is occasionally encountered. Wholly unimpaired central visual acuity cannot justify the assumption that there is no disease of the optic nerve. A rigorous ocular examination, with especial reference to the visual and color fields, may disclose the presence of the optic nerve mischief in a majorty if not in all

cases of cerebrospinal rhinorrhea. This phenomenon should then properly be regarded as an integral part of the symptom complex and not merely as a complication.

There can be no doubt that this case belongs to Thomson's group of undoubted cases of cerebrospinal rhinorrhea, as the examination of the cerebrospinal fluid, according to Halliburton's method, clarifies the only doubtful point.

Pike, N. H. A Case of Cerebrospinal Rhinorrhea with Double Optic Atrophy: Brit. Med. Jour., London, 1910, I, 1104.

A woman, aged 22, presented watery discharge from right nostril. At age of 12 she had a severe illness, chief symptoms being headache, vomiting, drowsiness, convulsions and unconsciousness, stiffness at back of neck. Eyes became prominent and at end of illness a year later she was quite blind.

After recovery occasional attacks still occurred. General expression of patient suggests congenital syphilis.

At the time of writing no ocular paralysis but marked nystagmoid movements of eyeballs. Polypoid tumor in nose on right side; from this nostril constant dripping of clear watery fluid. Tumor probably formed by continual soaking of spongy tissues. No sign of sinus trouble. Fluid does not stiffen linen. Cerebrospinal fluid.

In the light of Thomson's investigations, author does not doubt that this is a case of cerebrospinal rhinorrhea. He believes that in some of the cases classed by Thomson as "probable," if a repeated examination of the fluid had been made, a copper reducing substance would eventually have been found, as revealed in author's case, which did not show it at first. Author says it must be remembered that in such a diseased condition the character of the cerebrospinal fluid may be altered. For instance, in general paralysis of the insane there is no reducing substance.

Meyer, A. Escape of Cerebrospinal Fluid Through the Nose. Jour. Nerv. and Ment. Dis., N. Y., 1903, XXXI, 216.

A young man eight years previously injured vertex by striking it against a rock. Since that time increasingly severe headache and three years later ocular symptoms. Subsequently both eyes became blind; later attacks of numbness occurred on left side of face. In August, 1900, sudden onset

of oozing of fluid from right nostril, followed by improvement in all symptoms. At present time no facial palsy, but on opening mouth, jaw deviates to right. Several times the patient, while suffering from a cold causing occlusion of the nostrils, had gone into a deep sleep. A few months ago, without any occlusion, there was a general convulsion, and these attacks have been repeated. During oozing, fluid contained reducing substances. At time of writing it contained glucose, and was undoubtedly cerebrospinal fluid.

The writer was practically certain that the optic chiasma had been destroyed by a tumor.

Constantin, P. M.: Ecoulement spontané de liquide céphalo-rachidien par les fosses nasales. Bull. d'oto-rino-laryngol., Paris, 1919-20, N. S., XVIII, 205-7.

Man, aged 35. Dripping from right nostril only, about 860 cc. in 24 hours. No optic trouble. Analysis shows normal cerebrospinal fluid, and lumbar puncture produces exactly similar liquid, apparently not under hypertension.

In order to determine with what degree of facility the fluid passes from the subarachnoid cavity into the nasal fossa, the author injected a fluorescin solution at site of puncture. The patient was laid face downwards, with his head inclined forward. After an hour and a half the first fluorescent drop appeared at the end of the nose.

The intensity and rapidity of the flow only slightly diminished during the hours succeeding the puncture. Slight headache.

Radiography showed no abnormality in connection with ethmoid and olfactory groove.

The writer questions whether this was a case of hypertension of the anterior subarachnoid spaces, and only at this point; also why this hypertension should not involve the cerebrospinal fluid, as there appeared to be normal communication. Suggests a congenital malformation, with arrested development of the ethmoid, and a frontal encephalocele.

Quotes the opinion of M. Souques that there exists fetal communication between the lateral ventricle and the anterior olfactory lobe; that due to some unknown cause hypertension was produced, possibly only momentarily, which reestablished

the fetal communication between the right lateral ventricle and the olfactory bulb, on the inner surface of which originate the olfactory nerves which traverse the perforated lamina.

The theory of M. Souques is very convincing, and the author suggests that comparative embryology may possibly in the future offer an explanation for the pathogeny of spontaneous nasal discharges of cerebrospinal fluid.

McDougall, J. E.: Case of Idiopathic Cerebrospinal Rhinorrhea. Liverpool Med. Chir. Jour., 1910, XXX, 391-4.

Man, aged 31. At age of 17 had convulsions, twitching movements of right arm, followed by unconsciousness; also severe frontal headache. Operated on after a year, with improvement, but return after six months, accompanied by impairment of right vision, followed by left, and in eighteen months total blindness. Also loss of power in right arm and leg. No evidence of syphilis, either congenital or acquired. No vomiting. Lost sense of smell.

At 22, spontaneous flow from left nostril; intermittent. Hemiplegia and paresis of right face. Large trephine opening over left Rolandic area. Prominent eyeballs; sinuses healthy; nose normal.

Watery specimen stated to be cerebrospinal fluid, although there were two conflicting reports; but in one case specimen was doubtless associated with mild inflammation, as the albumin was slightly increased and the reduction less than normal.

Author cites Dr. Watson Williams' statement that the fact that one of the specimens did not reduce Fehling's solution did not necessarily imply a difference of methods employed, as the phenomenon is not constant.

Patient was given large doses of urotropin, which is said to be excreted by the cerebrospinal fluid in the form of formalin, for which substance the fluid was to be examined later.

Long duration of condition induces author to believe cause of rhinorrhea was intracranial tension. Both the history and symptoms indicate a chronic internal condition, rather than a tumor. Author believes that in spontaneous cases of discharge the cerebrospinal fluid escapes along the perineural sheaths.

A Case of Cerebrospinal Rhinorrhea. Herman Jarecky: Eye, Ear, Nose and Throat Monthly. 2:452, Oct., 1923.

A woman of 39 years, after a hot steaming bath of epsom salts, noticed her nose dripping. She experienced a feeling of weakness, almost collapse, and was told by her physician that her heart was affected. From that time on there was a constant dripping from left side of the nose, more marked at times, especially when leaning forward. When she sat up straight the fluid would run down her throat, causing an irritation, slight cough and constant swallowing. There was no sneezing or nasal irritation, and the discharge was without odor or color. The pillow had to be changed constantly; the handkerchiefs dried easily and remained soft, pliable and unstained, proving that the discharge was free from mucus. The amount of fluid passed from the nose was approximately 30 ounces a day. Laboratory findings revealed the discharge was cerebrospinal fluid. After rest and change of climate had failed to ameliorate the condition, the patient was given 10 drops of a solution (1 gr. to the minim) of sodium iodid in a glass of water three times a day, which treatment was followed two days later by a complete cessation of the flow.

Legros: Ecoulement spontané de liquide céphalo-rachidien par les fosses nasales. (Spontaneous Discharge of Cerebrospinal Fluid from Nasal Fossæ). Arch. Méd. d'Angers, 1911, XV, 369-76.

Man, aged 57, came to author, owing to sudden onset of profuse discharge from right nostril, shown to be cerebrospinal fluid. Four years previously had almost continuous headache, of several months' duration. No ocular trouble.

Paralysis and other cerebral symptoms soon appeared. Wassermann distinctly positive. A week after consultation temperature suddenly rose, patient fell into coma and died the following morning.

Author believes the cause of the flow may have been a syphilitic cerebral gumma or syphilitic nasocranial osteitis.

He cannot admit the theory of cerebral gumma with hypertension of cerebrospinal fluid, for the symptoms therefor were absent—i. e., headache preceding flow, dizziness, vomiting, etc. Indeed the absence of all symptoms prior to the discharge is the special feature of the case. Also, the sense of prostration and confusion in the head came on only after the discharge began.

Hysteria After Mastoidectomy Simulating Brain Abscess; Cerebrospinal Rhinorrhea in Same Patient. New York M. J., 116:279, Sept. 6, 1922.

A woman, aged 24, had had 14 admissions to various hospitals with seven operations. On the tenth day after radical mastoidectomy she had several convulsions, with rolling of the eyes, and she fell into a coma which lasted 48 hours. She began to vomit and this lasted several days. Her temperature had not gone up and her pulse was the same as before the operation. A spinal puncture was made and the fluid came out at the rate of 45 drops per minute. The fluid was negative, and the physical examination was likewise negative. The patient was given hypodermoclysis, and it was impressed upon her that more were coming should she vomit any longer. The vomiting returned and, after lavage and one hypodermoclysis, it ceased. When the patient was able to sit up in bed she complained of headaches and dizziness, and she held a handkerchief under her nose constantly. It was learned that five months prior to the mastoiditis she had developed rhinorrhea. There was no history of a cold or of an injury. The fluid was examined on several occasions and found to be cerebrospinal fluid. The mastoid wound healed but the rhinorrhea persisted. The X-ray examination was negative. The spot through which the fluid came was not located.

Cerebrospinal Rhinorrhea, with Report of a Case. J. E. Loftus: Laryngoscope, 33:617, Aug., 1923.

Woman, aged 40 years, single, who was first seen after she had been treated three months for sinusitis. She complained of a persistent dripping of clear fluid from the left nostril for the previous three months. The condition started after a heavy laughing attack, followed by severe sneezing, when patient became aware of a clear limpid fluid coming from her left nostril; associated with this was severe frontal headache extending to the vertex, and diminished somewhat when the flow increased. At the time of examination there was a continuous dripping of clear fluid from the left nostril; the quantity measured was one and one-half ounces for one hour. The flow altered or increased by the position of the head. The fluid was clear, odorless, tasteless, without sediment, and with slightly alkalin reaction. When the head was dropped forward there was

marked increase; when the head was thrown backward the fluid ran down the postnasal space and was swallowed. The quantity of fluid carefully measured during waking hours amounted to 32½ ounces. Nasal examination revealed marked congestion of the mucosa of the left nasal fossa; middle and inferior turbinates slightly hypertrophied; nasal septum sharply deviated; no evidence of pus in any of the nasal chambers or postnasal space; transillumination revealed rather large sinuses. The fluid seemed to come from the posterior portion of the roof of the nose and not from the middle meatus. The fluid had practically the identical composition of cerebrospinal fluid.

As the patient became depressed and melancholic, it was deemed advisable to send her to a hospital for a rest cure. After being there for a month and a half the fluid from the left nostril subsided; two weeks following the cessation of the flow, the patient was suddenly taken with a chill and rise of temperature to 104° F., associated with numbness of the entire body and severe headache. Two days later a semicomatose state developed, followed by facial paralysis, tremors of the body and auditory nerve deafness. Death ensued three weeks later from acute encephalitis. No autopsy.

Bregman: Über den spontanen Ausfluss von Cerebrospinalflüssigkeit durch die Nase. Arb. a. d. neurol. Inst. a. d. wien. Univ. Leipzig and Vienna, 1907, XV, 474.

Case 1.—Woman, aged 20, presented optic and cerebral symptoms, together with continuous nasal flow, characteristic of cerebrospinal rhinorrhea, and suggestive of a cerebral tumor or hydrocephalus. Nasal trouble gradually developed from fifteenth year. Psychic depression and impaired intelligence.

Case 2.—Woman, aged 25, was struck in 1889 on right temple by a piece of coal, with, however, no immediate consequences. Soon after she fell on her back on ice and fractured her occipital bone, losing consciousness. The increased severity of her condition dated from last (fourth) confinement. Presented many nervous symptoms similar to Case 1.

The course of the disease was very interesting. After initial psychic disturbances the headache increased after the fourth confinement and sight decreased. A flood of pus next flowed

out of right ear, with perforation of tympanic membrane. After this condition improved. Resection of mastoid performed, which, however, produced no results. Sudden improvement of condition, accompanied by new symptom, viz., watery discharge from nose. From that time consciousness returned, and patient recovered power of speech and gait. Watery flow from nose increased in intensity and became intermittent.

In this case the existence of a cerebrospinal tumor appeared most probable, and there can be no doubt about etiologic connection with the two traumata. The intervening time between the injuries and the appearance of the symptoms is the average period.

Comparing the two cases, it is significant that the nasal flow in both instances followed the appearance of the cerebral symptoms by a considerable interval of time: In Case 1, after four years; in Case 2, from one and a half to two years. The effect of the flow in Case 2 was speedy and marked improvement; in Case 1 the cerebral symptoms remained practically the same, and even seemed to coincide with exacerbation of general condition.

In both the flow was from the left nostril and presented the usual features of cerebrospinal rhinorrhea. Both patients died after the end of the clinical treatment.

In Case 1, with the object of establishing the relation of the nasal flow to the cerebrospinal fluid, a lumbar puncture was made. This showed the following remarkable phenomenon: The puncture, which immediately followed the collection of a large quantity of nasal discharge, produced no drop of fluid. On the other hand, when about 20 cc. of cerebrospinal fluid was extracted by puncture, no nasal secretion was forthcoming. This experiment appears to be unique in the literature, and the fact appears to show, not only that the nasal fluid is identical with the cerebrospinal fluid, but also that its flow must prevent the collection of large quantities in the skull and vertebral canal.

All the more surprising was the comparison of the aspect of the two fluids; the nasal discharge was white and clear as water, but the cerebrospinal fluid was yellowish. The albumin content was much greater (3/99).

Various authorities have shown that the yellow coloring of the cerebrospinal fluid indicates generally hemorrhage of the central organs; but it has been observed in other conditions, such as tubercular meningitis, severe forms of meningitis and superficial tumors rich in blood vessels, etc.

The author thinks the difference in color may have been due to the fact that the nasal secretion (not water) was not always the same in color. As there can be no doubt that the nasal flow was really cerebrospinal fluid, he thinks that possibly on its route to the spinal cord it undergoes change through contact with pathologic tissues in the arachnoid space. But he states that the conditions of circulation of the cerebrospinal fluid are not fully known.

He quotes Thomson and Berg with regard to diagnosis and route of entrance of cerebrospinal fluid into nasal cavity. He also mentions the possibility of abrasion of the base of the skull; moreover, in young persons, it sometimes happens that, if not yet entirely closed, the cranial sutures, as a result of pressure, become separated. Finally, a tumor can itself exert pressure on adjacent bones and effect a change in their form or abrasion.

Traumatic Cerebrospinal Rhinorrhea Caused by an Orifice in the Anterior Cornu of the Right Lateral Ventricle. Jose E. Olmos and Roman Lizondo. Semana med., Buenos Aires, 302:305, Aug. 16, 1923.

This case is unique, no other case in the literature having a true ventricular fissure. It occurred in a man of 26 years who was hit on the forehead by a bottle, the blow causing a fracture of the frontal bone with a wound 4 cm. in diameter. The patient lay in a state of coma for several days, after recovery from which he began to have continuous headaches and occasional attacks of Jacksonian epilepsy. Eight months after the injury, and on the occasion of awakening from an epileptic seizure, he began to note that fluid was dripping from his nose, which in a few days became a steady stream. Not until the ninth month did he seek medical treatment. At this time he became semiconscious, with pulse 58, involuntary micturition and defecation, and the amount of fluid escaping from the nose reached 150 cc. in 24 hours. Whenever the outflow was particularly large, there were vomiting attacks. Lumbar

puncture showed negative pressure when he was recumbent, but a pressure of 40 mm. when he sat up. When he was raised up for an X-ray photograph the exertion was followed by tonic and clonic convulsions of the right arm and left leg; the temperature rose suddenly, and the man died three days later without consciousness having returned.

Autopsy: Examination of the lamina cribrosa of the ethmoid shows it is not fractured. In view of the clinical history, the authors conclude the right lateral ventricle was opened up in the following manner: The traumatism caused immediate opening of the posterior wall of the right frontal sinus, the rupture of the dura mater at this point and rupture of the encephalic mass with production of consequent hemorrhage and hematoma, which served to keep the walls of this neoformed cavity separated, a cavity the posterior end of which was separated from the anterior prolongation of the right lateral ventricle by a very thin wall.

Following this there was a chronic inflammatory process, leading to adhesion of the dura mater to the posterior wall of the opened frontal sinus, as well as adhesion of the dura mater and soft meninges to the brain. This was the cause of the persistent irradiating headache toward the right side of the head, as well as the repeated attacks of Br-J. epilepsy. The tension of the cerebrospinal fluid was doubtless changed and increased through heavy alcoholic drinking. This tension of the cerebrospinal fluid in the ventricles, the epilepsy and the opening of the anterior prolongation of the right lateral ventricle in the neoformed cavity was caused by the traumatism and revealed by the nasal discharge.

While the above authors say that no other similar case has been recorded, the postmortem findings in the case of Wollenberg, 1909, showed a direct communication between the lateral ventricles and holes in the perforated lamina which connected with the nose.

Stein, Otto J.: Cerebrospinal Rhinorrhea; Report of Case. ANNALS OF OTOLOGY, RHINOLOGY AND LARYNGOLOGY, 1925, XXXIV, 4, 1269-1271.

A Polish woman, aged 45, married, applied for relief of a nasal discharge coming from her left nostril. Two years pre-

vious she had presented herself for treatment of nasal obstruction and anosmia.

Examination revealed a healthy appearing woman of average weight. There was impaired hearing, accompanied by some tinnitus. Both drum membranes were practically normal; the tubes were open; air conduction was reduced. The Schwabach was somewhat reduced, the Weber was not lateralized, the Rinne was positive. The upper tone limit was lowered, the lower tone limit was elevated. The hearing was reduced about 20 per cent. Both middle turbinals were hypertrophied and polypoid, and were removed with a snare at the time of first presentation, two years ago. Free nasal breathing was established and the sense of smell was restored.

One year later a watery discharge appeared from the left nostril. There was an absence of any irritative symptoms. Several physicians prescribed for her without giving any relief of symptoms. Six months after the onset she consulted Dr. Stein. The flow of fluid had been continuous and varied on changing the position of the head. With head forward or backward the flow increased. It always came from the left nostril and continued day and night. Many handkerchiefs were used each day, and after drying they remained soft and pliable. She had a slight headache, which was not influenced by the amount of flow from the nose. The blood pressure was 110 systolic. The eyes showed a mixed astigmatism. A test tube full of the fluid was collected for examination. The Wassermann reaction was negative. There were no cells, no mucus, but traces of albumin and dextrose, on two examinations. Atropin internally had no effect. Alcohol injection of Meckel's ganglion on the left side was performed without result. Benzyl benzonate solution, 20 drops three times a day, was administered, and after two weeks the discharge had almost ceased. After three weeks the discharge had ceased entirely and had remained so for five months.

Headache was not a pronounced symptom in this case, even after the cessation of the flow. Dr. Stein had observed four other cases in the past thirty years, two of them being traumatic. The treatment suggested and employed includes lumbar puncture, roentgen therapy and the internal administration of thyroid extract, atropin or benzyl benzonate.

REPORT OF CASE.

Mrs. J. P. M., age 34, married, and has three healthy children. She was born in Sicily and came to this country when 21 years old. Father died of pneumonia at the age of 62. Mother is alive and well, three brothers and three sisters alive and well; one brother died in infancy.

Her general health has always been good; had measles in childhood. In 1923 an examination of her eyes revealed a hypermetropia of two and one-quarter diopters; the fundi were apparently normal. On February 17, 1925, she consulted me regarding a nasal discharge, which was most marked on the left side. She had just recovered from an attack of influenza, was in bed for about one week with a high temperature and severe headache.

At this time there was a marked congestion of the nasal mucous membrane and a watery discharge from both sides of the nose, but most marked on the left side. Transillumination of the sinuses was negative. She appeared to have an acute coryza and was given some local treatment. I next saw her on March 22nd, at which time the watery discharge was much more profuse and was coming from the left side only. During the next eight weeks she was seen several times and given local treatment, which did not in any way alter her symptoms. At no time while she has been under my care has she been treated with the vacuum apparatus which is so often used in the treatment of sinus disease. Up to this time no thought was given to the possibility of this fluid being cerebrospinal. Owing to the fact that there was no pathology in the nose to account for the flow, a diagnosis of probable cerebrospinal rhinorrhea was made.

On Sunday, May 31st, the flow of fluid almost stopped, and she remarked to her husband that she hoped it would remain so. On Sunday evening, however, I received a call and was informed that the flow had returned and was much more profuse than at any previous time. She stated that I must do something to stop it or she would surely die. During the day that the flow had diminished she did not have any headache or other symptom that might result from the retention of the fluid. She was very nervous for the next few days; said that

she could not sleep and that the fluid swallowed while she was lying down caused her to be nauseated. She vomited several times. An X-ray examination at this time was negative as to the sinuses and the base of the skull. It was noted that this fluid did not stiffen the linen handkerchief, and the only other test made was one to learn whether or not the fluid contained a copper reducing substance. With Fehling's solution a copper reducing substance was found.

On June 5th she was referred to Dr. L. W. Dean of Iowa City. A diagnosis of cerebrospinal rhinorrhea was made, and, in order to make possible a further study of the case, Dr. Dean kindly put at my disposal the facilities of the University of Iowa College of Medicine. Taking advantage of this opportunity, a further study of this case was made, giving special attention to the cerebrospinal fluid.

REPORT OF NASAL DISCHARGE.

Date of specimen, June 8, 1925. Date of report, June 9, 1925. Colorless, odorless fluid, faint turbidity completely removed by centrifuging, leaving fluid water clear. Sediment small in amount, consisting mainly of squamous epithelial cells, with smaller number of polymorphs and an occasional small lymphocyte. Minute mucus shreds. No crystals. Protein: trace. Uric acid: 0.5 mg. per 100 cc. (approx.). Sugar, 0.081 per cent. Chlorides, 0.780 per cent. O. H. GAEBLER.

Date of specimen, June 8, 1925. Date of report, June 9, 1925. Colorless, odorless fluid with very faint turbidity which is completely removed by centrifuging, leaving liquid water clear. Sediment very slight in amount; consists mainly of squamous epithelial cells with smaller number of polymorphs and an occasional small lymphocyte. There are a few minute shreds of mucus. Specific gravity, 1.006. Protein, a trace. Nonprotein nitrogen, 24.7 mg. per 100 cc. Uric acid, 0.4 per 100 cc. (approx.) Sugar, 0.084 per cent. Chlorides, 0.860 per cent. O. H. GAEBLER.

Date of specimen, June 8, 1925. Date of report, June 9, 1925. Physical characteristics same as in previous specimen. Specific gravity, 1.007. Nonprotein nitrogen, 24.5 mg. per 100 cc. Uric acid, 0.5 mg. per 100 cc. (approx.). Sugar, 0.070

per cent. Chlorides, 0.760 per cent. Note—This specimen was collected directly into a chemically clean tube and analyzed at once. O. H. GAEBLER.

Date of specimen, June 11, 1925. Date of report, June 12, 1925. Volume of specimen was 8 cc. Entire specimen was used in uric acid determination, 1 cc. of each of the Folin-Wu reagents being added to 8 cc. of the fluid, instead of diluting. This made color obtained in uric acid determination much more comparable than in previous determination, hence improved accuracy. Uric acid determined both directly and by precipitation method. Direct: 0.39 mg. per 100 cc. Precipitation: 0.19 mg. per 100 cc. O. H. GAEBLER.

Report—Cell, 5 per cu. mm. Differential, polys 2, mononuclears 3. Giemsa's stain shows 6 lymphocytes and 4 polyps, together with an occasional epithelial cell containing various organisms (cocci and bacilli). A group of four endothelial cells were seen. The nature of the lesion cannot be determined by chemical or cytologic study but suggests a noninflammatory lesion. G. H. HANSMANN.

Chemical Analysis—Colorless, odorless fluid with very faint turbidity, which is completely removed by centrifuging, leaving liquid water clear. Sediment very slight in amount and consists of squamous epithelial cells with smaller number of polymorphs and an occasional small lymphocyte. There are a few minute shreds of mucus. Specific gravity, 1.006. Protein, a trace. Nonprotein nitrogen, 24.7 mg. per 100 cc. Uric acid, 0.4 mg. per 100 cc. Sugar, 0.084 per cent per 100 cc. Chlorides, 0.860 per cent per 100 cc.—By Gaebler.

October 16, 1925. Forty-two cc. fluid. Made strongly acid with 8 drops glacial acetic, heated to boiling, faint precipitate. Filtered through same filter repeatedly until clear. Filtrate, 38 cc.; 1 cc. was diluted with 5 cc. water; 2 cc. diluted fluid used for Folin-Wu sugar determination. Result: 0.097 per cent in original fluid. Remaining 37 cc. evaporated to about 1.5 cc. in pyrex dish, then poured into graduated centrifuged tube. Dish washed carefully with successive 0.5 cc. portions of water, washings added to liquid in tube and process repeated until contents of tube amounted to 4.7 cc. Centrifuged out a flaky white precipitate. Two and three-tenths cc. of concen-

trated fluid were placed in a test tube containing 0.5 g. of phenylhydrazin hydrochlorid-sodium acetate mixture, and heated in boiling water bath. Yellow ppt. in five minutes, increasing in amount, and grossly very much like glucosazone. Microscopic examination showed sheaves of needles, yellow, and not distinguishable from glucosazone. Left tube in water bath 25 minutes, then centrifuged, decanted, stirred up ppt. with 10 cc. water, centrifuged, decanted, and repeated this washing three times in same tube. Finally added 10 cc. water, heated to boiling, filtered and dried ppt. on filter paper at 105 degrees. The amount was very small, scarcely enough for melting point. The yellow compound decomposed (blackened) at 197-200 C. (corrected).

Remainder of concentrated fluid was treated as above until osazone was formed. Then after one washing only, a little water was added to precipitate in tube, the tube shaken, and then inverted on a piece of porous plate and gradually tilted so as to allow the fluid to run out slowly, and to keep the osazone from spreading too far. The piece of porous plate was then transferred to vacuum desiccator and left over night. Compound then bright yellow and dry. Sufficient for one-third inch, well packed substance, in bottom of melting point tube. Slight browning at 187.5 degrees Centigrade, then rapid melting at 190.5 (both corrected). Evolution of gas which spread the deep brown liquid resulting over an inch and a half of the melting point tube. O. H. G.

Report of X-ray Examination.—The films show the contour of the skull to be normal, except in the region of the occipital protuberance there is a concavity instead of the normal convexity. The sella turcica is flattened, but there is no definite destruction of the bone. In the region of the pituitary body there is evidence of slight increase in density. The sphenoid and posterior ethmoid sinuses are clear. The frontal sinus, anterior ethmoid and left antrum are clear, the right slightly blurred. DR. BUNDY ALLEN.

Physical Examination.—Throat: Faucial and lingual tonsils are chronically inflamed and diseased. Cervical glands are just palpable. Larynx negative. Nose: Septum deviates to the right. Moderate hyperplasia of the turbinates. Posterior rhino-

scopy showed hyperplasia of the posterior ends of the middle turbinates. Some mucopus running down the posterior border of the septum. In region of the pharyngeal tonsil there is a red mass about 1 cm. in diameter which seems to present an opening. On further observation of this mass it appears that it is nothing more than a hypertrophied nodule of the pharyngeal tonsil. It has been studied repeatedly and no opening could be found, but fluid could be seen escaping from around the mass. Ears negative. Heart: Systolic murmur, slight enlargement. Urine, negative for albumin and sugar. Lungs negative. Blood: R. B. C., 4,820,000; leuc., 9,700; polys, 58 per cent; S. M., 36; L. M., 6; Hb., 90 per cent. Blood pressure, 128-90. Blood Wassermann negative. Chemical examination of blood: Hemoglobin, 11.1; nonprotein nitrogen, 33; uric acid, 2.1; urea nitrogen, 10.2; sugar, 0.083; chlorids as NaCl, 0.511. (V. C. Myers.) Wassermann on cerebrospinal fluid negative. Dr. O'Brien reports eye findings negative. Dr. Van Epps reports neurologic findings negative.

Summary: The patient has a discharge of cerebrospinal fluid coming from the left nostril. It seems to accumulate between the anterior end of the middle turbinate and the septum. When patient leans forward a considerable amount of the fluid will escape at one time. Aside from a moderate deflection of the nasal septum and hyperplasia of the turbinates there is nothing abnormal in the nose. It is impossible to see the point where the fluid escapes from the cranial cavity, but it is apparently from somewhere in the posterior half of the cribriform plate.

Diagnosis: After a consideration of all the findings and the history of this patient, the writer feels that it is an undoubted case of cerebrospinal rhinorrhea, due to an internal hydrocephalus, which has resulted from an obstruction to the normal circulation of the cerebrospinal fluid. This obstruction is probably caused by a low grade inflammation or pressure from a slow growing tumor of the base.

Treatment: In going over the literature I am unable to find any definite line of treatment outlined. Various remedies have been tried but none have reported success. One observer reports that his patient recovered after he had administered sodium iodid in 10 grain doses three times daily for two days.

This cure was probably incidental to the administration of the drug. In the case here reported I have tried adrenalin subcutaneously, atropin internally, sodium iodid internally, but none have seemed to make any change in the flow of fluid from the nose. The only treatment that made any change in the amount of fluid was restriction of the amount of fluid intake.

In a personal communication of Sir St. Clair Thomson to Dr. L. W. Dean, repeated lumbar punctures are suggested and avoidance of any intranasal interference. This patient refused a lumbar puncture, either as a therapeutic or diagnostic measure.

Progress from November 1, 1925, to April 1, 1926:

The condition of this patient remained stationary until December 22, 1925, when the flow ceased entirely. She did not complain of any headache or other symptoms which might be due to an increase in intracranial tension. During the month of January she felt exceptionally well and gained several pounds in weight. On January 31, 1926, she had a very severe headache, and the following morning noticed that there was a small amount of fluid coming from the left nostril, but the headache was not relieved. I saw her on February 2, and the fluid was escaping at the rate of one drop per minute. The fluid had the same appearance as formerly and did not stiffen a linen handkerchief.

At the present time, April 1, 1926, there is practically no fluid escaping from the nose and she has no complaint.

Summary of Cases Reported.—Including the case here reported, there are 21 in this series. The ages ranged from 22 to 57 years, and there were 13 females and 7 males. The nostril affected was the left in nine instances, right in eight instances, bilateral in one and not stated in three. In Thomson's series of nine undoubted cases there were five left side, one bilateral, one right, two not stated. The duration of the flow was not stated in every case but ranged from one week to nine years in this series. Eye symptoms were reported in ten cases and cerebral symptoms in fourteen cases. Injury could be considered as an etiologic factor in six instances. The escape of fluid persisted in nine cases, and the patients were alive at time of report. The flow had ceased in six cases. Six of the twenty

cases reported were dead when reports were published. In the progress of the writer's case there has been little change. General condition is better than in June and she has gained in weight. No eye and no cerebral symptoms have been observed up to this time. She complains of some headache but it is not severe and apparently does not interfere with her rest or with attention to her usual duties about her home.

Her principal complaint now is the escape of fluid from the nose, which makes the constant use of the handkerchief necessary.

I take this opportunity of expressing my gratitude to Dr. L. W. Dean, Dean of the College of Medicine of the University of Iowa, for placing at my disposal all the facilities of the university, and for many valuable suggestions.

Thanks are due also to Professor Victor C. Myers of the Department of Chemistry, and his assistant, Dr. O. H. Gaebler, and to the other departments that have cooperated in the carrying out of these investigations.

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507 LAUREL BLDG.

LXXXIX.

BIOPSY IN SUSPICIOUS (CARCINOMATOUS) GROWTHS OF THE LARYNX.*

By Charles J. Imperatori, M. D.,

New York.

The early diagnosis of carcinoma of the larynx is of supreme importance. The difficulty in the early diagnosis of growths, whether benign or malignant, that are of small size and located on the vocal cords or ventricular bands, lies mainly in their great similarity of appearance, especially so when viewed by the indirect method. The extent of a growth will surprise one long experienced in indirect laryngoscopy when the periphery of the growth is investigated by direct vision. However expert or well trained the eye is, a positive diagnosis cannot be made by these methods alone. When one is dealing with the possibility that the growth under consideration may be a malignant one, the greater becomes the necessity of a certainty in the diagnosis. The general history, including the onset of hoarseness or other symptoms directly referable to the larynx, and the exclusion of constitutional conditions, must be carefully considered.

There is but one positive method of arriving at a diagnosis of carcinoma of the larynx, and that is by microscopic examination of a piece of tissue excised from the larynx at what appears to be the periphery of the growth and normal tissue, and one from the growth itself.

The one objection to arriving at a diagnosis per microscope —that is, by a biopsy—of a growth of the larynx has been the objection to a biopsy done elsewhere, because of the trauma to the tissues and the possible crushing of cancer cells into the lymphatic channels and thus further spreading the growth to remote locations, or by the mere act of breaking the capsule of the neoplasm to stimulate it to more rapid growth.

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*Read before the American Laryngological, Rhinological and Otological Society, Montreal, Canada, May 31, 1926.

The question of biopsy, according to D. Bryson Delavan,[1] "was pretty well settled twenty-five years ago. The general verdict then and since has been against it." Norval H. Pierce[2] appears to have the same views as Delavan. Freer[3] considers that "this (biopsy) might be done without question were it harmless to the patient, even though—as it usually is—it were merely to pedantically prove the obvious; but the excision demanded is certainly not harmless, for in order to avoid error due to superficial and inadequate excisions, that include only healthy tissue and do not reach the underlying carcinoma, it is necessary to cut out a large piece of flesh. Such excisions have been often observed to greatly stimulate the growth of the cancer, and from the open surface carcinoma cells are likely to be carried far by the lymphatics."

MacKenty[4] says "he is very much opposed to biopsy if it can possibly be avoided. In 87 cases, three biopsies were done to verify the diagnosis. If done, it should be done close to the operation. He believes it tends to spread the disease." However,[5] "he does feel that if a specimen must be taken, sharp cutting instruments should be used." It would seem from clinical observation that the objections of these laryngologists and others are not borne out by facts, and it is the opinion of a great many that it is not.

In a paper entitled "Diagnosis and Treatment of Cancer, from the Pathologist's Standpoint" (from the Institute of Cancer Research, Columbia University, T. C. Wood, director), William H. Woglom says: "The advisability of excising part of a tumor for diagnosis has always been an anxious question with the surgeon, yet it can be answered in the laboratory. Wood has removed fragments from transplanted tumors in animals, and, after a sufficient time, has subjected the lungs to examination. There were no more metastases in the operated animals than in the controls, whence he was able to conclude that—in suitable cases, at any rate—biopsy is not so dangerous as has been feared." This author further states that experimentation on animals showed that prolonged palpation of a tumor in an effort to reach a diagnosis was dangerous, in that pulmonary metastases would occur. Tyzzer and Knox have definitely proved that pulmonary metastasis is much more ex-

tensive in rats and mice after repeated massage of their tumors than it is in control animals.

Goldsmith[6] of Toronto, Harmon Smith[7] of New York, Mayer[8] of New York, Fraser[9] of Edinburgh and Coakley[10] of New York are all of the opinion that a biopsy is always justifiable and is the proper means of arriving at a diagnosis of carcinoma of the larynx.

The discussion following Dr. Mullin's paper entitled "Diagnostic Limitations in Laryngology," on page 213 of the 1924 Transactions of the American Laryngological Association, and the discussion following "A Case Report of Laryngeal Carcinoma, etc.," by Dr. H. H. Forbes, on page 78 of the 1925 transactions of the American Laryngological Association, are of interest, and one gathers from the different opinions expressed that the majority of those taking part in these discussions was in favor of doing a biopsy.

The vocal cords have no submucous tissue and are very poorly supplied with lymphatics. The lymphatics[11] from the upper surface of the vocal bands pass upward, gradually becoming more abundant until at the upper aperture of the larynx they are very numerous. The lymphatics of the subglottic region are less numerous than those of the supraglottic region but become more numerous lower down, gradually forming larger trunks that merge into the jugular or supraclavicular nodes. It has been very aptly stated that the vocal bands are the watershed of the lymphatic system of the larynx. Growths located on the cords extend very slowly along the lymph channels. It would seem, that in accordance with the anatomic conditions found in the vocal cords, the further away the cancer from them the greater the danger as regards metastasis and the deeper involvement of the surrounding tissues.

A positive diagnosis that is arrived at by finding the characteristic cell elements in the mass submitted for microscopic examination puts at rest all doubts as regards the nature of the growth under consideration, and upon these findings depend entirely the method of treatment.

Occasionally a negative report from the piece of tissue submitted for examination is returned. Either insufficient tis-

sue was submitted or the growth that appeared clinically as a carcinoma is a tubercular, syphilitic or a chronic inflammatory one. A positive biopsy is of greatest importance. A negative one must be given consideration until the rest of the clinical picture can be made to agree with such findings.

Necessarily a biopsy is not being done on what appears to be a hemangioma, polyp, papilloma or fibroma. Nevertheless, all growths removed from the larynx—whatever their appearance clinically—should be submitted to careful microscopic study. Numbers of cases that appear clinically as simple hypertrophies, polyps or papillomata are found to be tubercular.

Supplementary to a biopsy in a given case of hoarseness, a preliminary chest examination should be made, and this should be confirmed by a roentgenogram, sputum analysis, Wassermann test and other usual clinical examinations.

CONCLUSIONS.

A biopsy of a tumor of the larynx, to be properly performed, should consist of an excision with a punch forceps having sharp cutting edges. If possible, two pieces of tissue should be excised—one from the periphery and one from the center of the new growth.

Crushing operations should be avoided.

Cauterization following the excision does not appear to be necessary.

Suspicious growths with negative findings as regards carcinoma are considered tentative malignancies until proven otherwise.

A careful history that includes the age, habits, environment, onset of symptoms referable to the larynx, condition of the teeth, tonsils and sinuses, and the usual clinical methods of investigation should be considered.

If necessary, a second biopsy should be done.

However, no suspicious growth of the larynx should be excised for microscopic investigation without proper explanation to the patient—or to some responsible party closely connected to the patient—that should the growth prove to be malignant, some type of major surgical procedure—depending entirely on the size and location of the growth, is to be instituted immediately.

In the author's experience, no ill results have ever occurred following a biopsy.

Finally, may I be permitted to quote the words of that renowned and eminent laryngologist, Sir Felix Semon: "As the successful treatment of this disease (carcinoma) depends entirely upon early diagnosis and prompt surgical measures, removal of a portion or the entire growth by endolaryngeal methods should be practiced at the earliest moment, with a view to microscopic examination and accurate diagnosis."

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XC.

PRIMARY OSTEOMYELITIS OF THE MASTOID BONE (TRAUMATIC) WITH REPORT OF A CASE AND REVIEW OF THE LITERATURE.

By Myron E. Kahn, M. D.,

Chicago.

Cases of socalled primary mastoid—i. e., not occurring as the result of an extension of an otitis media to the mastoid process or cells—are undoubtedly rare. Some authors consider that a true primary mastoiditis can only result from a mastoid injury or as a metastasis from a systemic focus of infection. While cases of the latter type are not infrequently reported in literature, traumatic cases are very rare.

Before discussing the literature of the subject I desire to report the following case:

L. K., 9 years old, white girl, admitted to hospital June 14, 1925, with pain and swelling behind right ear.

Onset and course: Four weeks ago was struck by a ball behind right ear. Has had pain behind ear since, with many attacks of vertigo and headache. The pain was worse at night and disturbed her sleep. A week ago swelling and tenderness developed behind right ear. No pain in ear. Temperature at times as high as 104. No vomiting. Child always constipated.

Previous illnesses: Measles, eight years ago; mumps, two years ago; varicella, three years ago; no previous ear trouble.

Family history: Negative as to disease. She is only child. No deaths or miscarriages.

Physical examination: Well developed, poorly nourished white female.

Head: No deformity. Scalp negative.

Pupils: Normal, equal and symmetric. React well to light. No nystagmus or strabismus. Some inflammation of the eyelids.

Ears: Left negative. Whispered voice at 4 meters. Right: Small amount of cerumen and desquamating epithelium. Some sagging of posterior wall. Redness and tenderness behind right ear. Whispered voice 2½ m.

Nose: Negative.

Throat: Negative.

Blood: W. B. C. 15,150.

Treatment: June 15, 1925. Hot applications to right ear.

June 16, 1925. Urine negative.

White blood count, 11,600.

June 17, 1925. White blood count, 10,800. Child spent a comfortable day. No spontaneous pain. Tenderness on pressure behind right ear.

June 18, 1925. White blood count, 15,200. Canal walls seem to be red. Drums not bulging or red. No pus in canal. No discharge from middle ear.

June 20, 1925. White blood count, 17,600. Swelling behind right ear seems to increase. Definite fluctuation.

Examination by Dr. Kahn: Soft fluctuating mass behind right ear, region of mastoid, very tender. Ear pushed forward. Postauricular crease absent. Drums dull, no bulging.

Diagnosis: Mastoiditis.

Operation: Dr. Kahn. Assistant, Dr. Zeisler. Anesthetist, Miss Welke. Ether.

Skin incision made one-fourth inch behind ear over mastoid, down to bone. Large amount of free pus. Cortex hard. Small perforation in region of antrum. This was enlarged. Cortex removed. Bone soft. All cells removed. Antral opening enlarged and pus and granulation tissue removed. Drained. Closed in usual manner.

June 22, 1925. Culture of pus showed streptococcus hemolyticus.

June 25, 1925. Child in good condition.

July 3, 1925. Child up and around. White blood count, 8,500.

July 12, 1925. Child discharged.

Diagnosis: Primary mastoiditis due to injury.

In discussing primary mastoiditis it is necessary to remark that there is some divergence of view in regard to what is meant by it. Jacques and Gault[1] consider as true primary mastoiditis only those which arise from traumatism or from an

immediate contamination of the osseous tissue of the temporal bone by microorganisms circulating in the blood. These authors distinguish a periostitis from an osteitis. Politzer[2] considers that mastoid periostitis may result from cold or from external traumatism.

Salinger[3] thinks that a primary periostitis of the mastoid may occur independently of any infection of the tympanic cavity or mastoid cells. Its etiology is traced to typhoid, actinomycosis, breaking down of the superficial postauricular glands, erysipelas and other causes. Salinger thinks that no case should be considered primary periostitis unless every connection with a tympanic or mastoid infection can be definitely ruled out.

Dabney[4] says that the term primary mastoiditis, as it has been designated in the literature, is misleading, since the infection must be primarily in the mastoid cells and not secondary to an inflammation of the middle ear, that has cleared up. It is possible to conceive of a blood borne infection after a severe local injury, as in osteomyelitis of other bones, although there is no more reason to expect such an infection in the mastoid than in other cavities, such as the accessory sinuses.

Chavanne[5] thinks that only such cases should be considered primary as: (a) cellulitis in which the affection is localized either in the antrum or in one or more cells to the exclusion of the antrum; (b) Extracellular osteitis of the apophysis. Chavanne admits only a hematogenous infection and excludes mastoiditis following a catarrhal otitis or a cured acute purulent otitis, traumatic mastoiditis, syphilitic or tubercular osteitis of the mastoid apophysis, pseudoprimary mastoiditis in which the infection has only apparently avoided the middle ear cavity and affected the mastoid.

McCuen Smith[6] would confine the term primary to those mastoiditides resulting from metastases or traumatism.

Heiman[7] says that we may speak of a primary mastoid osteitis when there is a strictly limited hard swelling, the covering skin being either not attacked by inflammation or only very slightly so with absence of inflammatory symptoms on the external auditory side, and when any recent affection of the ear or of the soft parts of the mastoid apophysis (such as phlegmon) and of the periosteal covering can be excluded.

It would appear that the mastoid, either the periosteum or cortex, might become inflamed in a variety of ways without involvement of the middle ear. First, by a regional traumatism which may bring infection directly to the covering of the mastoid or to the osseous tissue itself, or else by the effects of the injury making the region a locus minoris resistentiæ for organisms circulating in the blood.

Traumatisms to the external ear and mastoid region are very rare as compared with injuries to other parts of the head and the face, but the mastoid portion of the temporal bone, situated as it is on the outer surface of the skull, is likely to be fractured by any direct blow or fall in this region. Copious hemorrhage from the ear in general indicates a fracture of the temporal bone, which may or may not involve the mastoid.

In the traumatic case which I report, the mastoiditis was probably due to the injured mastoid region offering a favorable location for organisms circulating in the blood. The child has been the subject of several previous general infections, and cultures from the mastoid showed an abundance of hemolytic streptococci.

Traumatic mastoiditis is only casually mentioned in otologic textbooks. Only a very limited number of cases are reported in the literature; and, as I have nowhere found such cases collected for reference, I thought it would be of interest to collect all that I could find in the literature. Short histories of these cases, to the number of twenty-eight, will be found at the end of this report. In these I have not included gunshot injuries, such as war wounds, or those occurring in civil life from attempted suicide or shootings. Gunshot injuries in the ear and mastoid region have been reported by Sune y Molist,[8] Hassler,[9] Sebileau,[10] Schwarzkoff,[11] Lewin,[12] Mauclaire,[13] Black,[14] Clay,[15] Beck,[16] Neuhof and Cocks,[17] Vandenbossche[18] and Merelli.[19]

Other traumatisms which have produced mastoiditis, such as the deliberate pouring of caustic fluids into the ear canal, are also omitted. Cases of this kind have been collected and reported by Goldenberg,[20] Nerger[21] and others.

There are also the isolated cases of mastoiditis, provoked by operative procedures, such as irrigation of the nose and tam-

poning of the nasal fossæ, to which Sebileau[22] has referred.

A mastoiditis provoked by an aseptic traumatism which simply awakens a latent otogenous affection cannot be regarded as a true primary traumatic mastoiditis.

The second method in which infective organisms may be carried directly to the mastoid region is by the blood or lymph channels in the case of a systemic infection. Dabney[4] says that the most convincing argument as to the possibility of infection of the mastoid by the blood stream is furnished by a study of osteomyelitis in which, according to Adami, the causal agents reach the affected part, either directly or through the blood stream.

The infecting agent may be brought directly into the antrum by the blood or through the tube into the antrum without infection of the tympanic cavity. The many cases reported in literature of mastoiditis, following systemic streptococcic, staphylococcic and other infections, leaves but little doubt that such an etiology is extremely plausible; although why the mastoid, if strictly healthy, should be selected is not clear. It seems rather reasonable to suppose that in such metastatic cases the resistance of the mastoid or antrum was reduced by some old or latent affection. A number of cases with this probable etiology have been reported in the literature.

Henrici,[23] Eeman,[24] Luebbers,[25] Hurd[26] and Davis[27] have reported on tubercular primary mastoiditis; mastoiditis following scarlet fever has been reported on by Ballenger,[28] Kiser,[29] Ruedi[30] and others; Hays[31] and Basavilbaso[32] have reported cases after influenza; Masier,[35] after puerperal fever; Green,[34] after typhoid; Shemely[35] and others, after syphilis. Dunlap[36] reported fifteen cases of streptococcal hemolytic mastoiditis following an epidemic of sore throat, and quite recently Stout[37] also reported on streptococcal mastoidites.

Seeing that there is a divergence of opinion as to what constitutes a true primary mastoiditis, it is only to be expected that not all cases reported as primary mastoiditis in the literature would be universally accepted as such. Of 47 cases collected by Dabney[4] in 1915, he admitted only 24 as authentic and added two cases of his own. Hempstead[38] of the Mayo Clinic, reporting in 1923, added 26 more cases collected from the American and English literature, together with three cases

from the clinic. Other cases, not included in Dabney's and Hempstead's lists, which I have found in the literature, are mentioned in the bibliography. These cases of mastoiditis, "without apparent middle ear infection or symptoms," are now becoming so common that they scarcely possess the interest that was formerly attached to them.

In regard to the classification of the case which I report as a primary mastoiditis, Dabney says that all cases of true idiopathic mastoiditis have the following common features: (a) rapidity of convalescence; (b) occurrence of subperiosteal abscesses or exaggerated edema; (c) freedom from absortive results. The traumatic case now reported fulfilled these criteria. When suppuration does not follow an injury in the mastoid region there may be complete regression or a thickening and hyperplasia only of the periosteum.

CASES OF TRAUMATIC MASTOIDITIS REPORTED IN THE LITERATURE

Case 1. Burnett (Amer. Jour of Otol., 1882, IV, 119).—Man, 24. Struck behind left ear; horizontal wound running backward from meatus through auricle and communicating with a deeper wound through the mastoid part and posterior wall of auditory canal; facial paralysis; loss of hearing; severe hemorrhage. On examination 26 days later, deep wound, granulated; piece of spongy bone in canal. This became detached later and was removed. Was evidently composed of mastoid cells. Evidently the facial canal and its nerve had been severed by the traumatism. Mastoid wound healed.

Comment: This is an instance of traumatic mastoiditis with concomitant middle ear symptoms.

Case 2. Haug (Aerztl. Sachs. Zeit., 1902, VIII, 46). Boy, struck by a hard playing ball directly behind the left ear—pain and blood from ear; hearing disturbed for days; on twelfth day profuse discharge from middle ear and discoloration over mastoid.

Diagnosis: Fracture of mastoid part of petrous bone. On operation acute middle ear purulent inflammation; posterior perforation; subperiosteal abscess; acute mastoiditis; fracture of mastoid. Sequestra removed and mastoidectomy. Recovery with preservation of hearing.

Comment: This case is similar to Case 1.

Case 3. V. Anrooy (Rev. Hebd. d. Laryngol., 1904, I, 153).—Man kicked by cow in region of the ear. Signs of mastoiditis appeared a few days later. Tympanum intact. Retroauricular swelling increased, the tympanum became involved and paracentesis yielded a mucopurulent discharge. Trepanation showed the mastoid cavity filled with pus.

Comment: Apparently primary mastoiditis, due to trauma, with secondary involvement of middle ear.

Case 4. Haskins (Arch. Otol., 1905, XXXIV, 233).—Woman fell on occipital region; hemorrhage in drum membrane. Two weeks later swelling behind and below ear with fever. Ice applied to mastoid; paracentesis drew serous fluid. Recovery.

Comment: Questionable traumatic mastoiditis with spontaneous recovery, with concomitant middle ear symptoms with spontaneous recovery.

Case 5. Oertel (Arch. f. Ohrenh., 1908, LXXVIII, 300).—Boy, 3. Severe contusion of head with hemorrhage from right ear, nose and mouth; left sided facial paralysis; tympanic membrane intact. Mastoiditis. On operation fractured mastoid with displaced fragments. Petrous portion intact. Recovery.

Case 6. Raffaele Vitto-Massei (Refer. Arch. f. Ohrenh., 1911, LXXXIV, 124).—Man struck by wagon on right side of head; on operation, suppuration and osteoperiostitis of mastoid. Recovery.

Comment: There is no statement whether middle was intact or not.

Case 7. Imperatori (Ann. Otol., 1915, XXIV, 660).—Child, six months old, fell, striking head behind left ear. No bleeding. On third day retroauricular swelling, fever, bulging drum. Drum incised with issue of blood and mucopurulent fluid; smears showed pneumococci; diagnosed as mastoiditis with subperiosteal abscess. On operation fracture found in front of squamomastoid suture; mastoid cavity full of pus and detritus. Bone covering sinus necrotic; probable jugular bulb thrombosis. Child died.

Case 8. Dench (Discussion on Phillip's paper, Ann. Otol., 1917, XXVI, 870).—Saw a case of rupture of the ear drum following a fall. The mastoid was opened later. A small area

of suppuration was seen with a fracture through the squamous plate and entering the mastoid. Recovery.

The following cases, of which a brief review is given, are reported in the literature as of traumatic origin. Some of them are simply instances of suppuration of the mastoid bone subsequent to an injury, producing a suppurative otitis media. Nevertheless, mention is made of them because of the element of trauma in their origin.

In addition to these cases, Angelini[39] in 1900 reported a traumatism in the mastoid region. I have been unable to consult the original reference, which is given in the bibliography.

Case 1. Moullin (Med. Press and Cir., 1894, LVII, 278).—Boy, 14, received severe blow over right mastoid region some weeks previously; headaches; on operation an abscess superficial to periosteum found and evacuated. Symptoms continued and abscess reopened. Mastoid trepanation, but no disease found. Ten days later symptoms intensified. Died in coma. Autopsy showed no middle ear disease, but there was a very old encysted abscess in left temporosphenoid lobe which apparently had been roused to activity by the blow on the right side.

Case 2. Badt (Inaug. Dissert., Munich, 1897. Abstract in Arch. f. Ohrenh., 1899, XLVIII, 135).—Man, 36, who six days before had received a severe blow over left mastoid region. Otoscopic examination and diagnosis: Hematotympanum traumatism. Exudate in middle ear was absorbed and paracentesis was unnecessary.

Case 3. Badt (Inaug. Dissert., Munich, 1897. Abstract in Arch. f. Ohrenh., 1899, XLVIII, 135).—Boy, 16, struck by stone behind right ear three weeks previously. Apex and base of mastoid very tender on pressure; tympanic membrane discolored. Diagnosis: Hematotympanum traumaticum. Paracentesis and drainage of exudate. Recovery.

Case 4. Badt (same reference).—Man, 22, fell on left posterior ear region. With loss of consciousness and bleeding from left ear. Tympanic membrane discolored and fissured. Condition cleared up after twelve weeks with slight impairment of hearing but no infection.

Case 5. Szenes (Ann. d. Mal. d'Oreilles, etc., 1898, I, 347).—Man, 30. Thrown violently from carriage; contused wound

of left parietal bone, apparently without fracture. Unconscious forty hours. After six weeks slight hemorrhage from left ear for nine days. After nine months the left tympanic membrane appeared normal, but there was absolute deafness in this side, apparently due to labyrinthine commotion.

Case 6. (Same author and reference).—Man, 32. Kicked by horse, hemorrhage from left ear; auditory canal ruptured near tympanic membrane. Unconscious for twelve days. Probable basal fracture. The hammer bone was fractured. Suppuration for several months. Recovery.

Case 7. Szenes (Ann. d. Mal. d'Oreilles, etc., 1898, I, 347).—Child, 2 years, fell from a table. Hemorrhage from right ear through fissure of external auditory canal; pus later. Labyrinthine disturbances. Recovery without operation.

Case 8. Burnett (Arch. Otol., 1899, XXVIII, 100).—Man, 63. Struck by brick on right side of head; extensive laceration of auricle and complete section of auditory canal with partial detachment of sternocleidomastoideus tendon and splintering of tip of mastoid. Immediate operation. Fistula formed from the denuded bone to the sutures in lower part of the reformed auditory canal with slight suppuration. Complete cure after two months.

Case 9. Heiman (Ann. d. Mal. d'Oreilles, etc., 1899, XXV, 475).—Man had received a heavy blow from a shoe over the left ear and mastoid apophysis. There was pain for some months in the region of the injury. The ear was not involved. Fifteen years later the man was operated on for an acute otitis media, and the mastoid apophysis was found sclerotic and with a subdural abscess.

Case 10. Berens (Arch. Otol., 1905, XXXIV, 233).—Man fell on chin; bleeding from ear; no cerebellar symptoms except shock; drum membrane ruptured; canal normal. Seven days later mastoid swelling, pain and fever; on operation mastoid was healthy but there were several hemorrhagic areas. Recovery.

Case 11. Oppenheimer (Arch. Otol., 1906, XXXV, 145).—Man, 44. After dynamite explosion blood discharge from left ear. Two days later inflammation of external auditory canal and some serosanguinous exudation; perforation of tympanic membrane and steady purulent discharge. Operation some

months later showed mastoiditis and fissure fracture within tympanic cavity. Recovery with much loss of hearing.

Case 12. Panse (Arch. f. Ohrenh., 1908, LXXV, 69).—Man, 30, struck by beam in face; unconscious; hemorrhage from right ear and nose; operation one month later showed mastoid cavity infiltrated with blood and a tympanomastoid fissure. Recovery.

Case 13. Habermann (Mitteil. d. Vereine. d. Aerzte in Steiermark, 1908, Abstract in Arch. Internat. de Laryngol., 1909, XXVII, 681).—Man fell from horse seven days previously; pus in left ear. Voluminous granulations adherent to tympanum; pus in region of Shrapnel's membrane; internal ear seemed intact. Probable fracture going through drum and internal part of auditory canal; facial paralysis. Electrical treatment. Recovery.

Case 14. Schwarzkopf (Arch. f. Ohrenh., 1908, LXXVI, 61).—Man. History of an injury to the external ear and auditory canal four years before. Occlusion of the canal, suppuration and fistula formation. Operation—removal of posterior wall of canal and cortex of mastoid process; large cholesteatoma. Recovery.

Case 15. Midowski (Arch. f. Ohrenh., 1908, LXXVII, 263).—Autotraumatism to left ear by soldier to avoid military service. Suppuration several months later with involvement of mastoid, as shown at operation, with extradural abscess, sinus thrombosis and brain abscess. Edema of posterior region of left ear over mastoid. Operated but died.

Case 16. Raffaele Vitto-Massei (Refer. Arch. f. Ohrenh., 1911, LXXXIV, 124).—Man fell while dizzy. Loss of consciousness. Bleeding from mouth, nose and right ear. Left facial paralysis. Investigation twelve days later showed ecchymosis in right mastoid region. Membrane congested and perforated. Not operated upon. Probable basal fracture.

Case 17. Humblet (Larynx., etc., 1913, VI, 136).—Avulsion of an infected wisdom tooth followed by primary mastoiditis. On operation no pus or serosity in the antrum or mastoid cells. Tympanum normal on first examination but subsequent symptoms of left mastoiditis demonstrated on later operation.

Case 18. Phillips (Ann. Otol., 1917, XXVI, 870).—Man, 65. A spike of grass had entered the ear canal and injured the

drum, followed by discharge. Mastoiditis later. When operated on the mastoid was filled with granulation tissue and pus. Staphylococcic infection.

Case 19. Schonbauer (Arch. f. klin. Chir., 1920, CXIV, 514).—Severe fall on right side of skull with injury to external ear and injury to apex of mastoid process. Operated upon at once. Despite the opening of the mastoid cells and despite a slight later infection of the soft parts, there was no otitis media and no disturbance of hearing.

Case 20. Malan (Arch. Internat. d. Laryngol., 1922, XXVIII, 373).—Soldier injured in right mastoid region; otorrhagia followed by purulent discharge; pain over posterior part of mastoid; operation showed linear fracture involving sinus transversus and fallopian canal. Pus and clots filled the cells. Recovery. The fracture was limited to the mastoid.

SUMMARY.

1. A case of primary osteomyelitis of the mastoid bone due to trauma is reported.

2. Other instances of mastoiditis following trauma are briefly reviewed. The references in the literature to primary mastoiditis due to trauma or otherwise are brought up to date.

3. All those cases of mastoiditis in which the middle ear at no time was involved are considered primary, regardless of the cause of the mastoid involvement.

4. Most of the reports on traumatic mastoiditis in the literature had simultaneous or secondary middle ear involvement. Some of them are pure fractures of the mastoid bone.

5. The case reported by us was a typical suppurative osteomyelitis of the mastoid with the middle ear apparently intact at all times. Such instances are, a review of the literature indicates, extremely rare.

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104 SOUTH MICHIGAN.

XCI.

FOREIGN BODIES IN THE ACCESSORY NASAL SINUSES.

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My interest was first aroused in this subject by a case that came under my observation which proved to be an infection of the maxillary sinus, later shown to be due to the presence in the sinus of a foreign body of unusual character, viz., a pipe stem.

I had not before observed a case of a foreign body in the maxillary sinus, and I was interested in knowing of its frequency or rarity, and in looking into the literature as far back as 1890 I found that in the thirty-three years following, one hundred and four observers had reported one hundred and ten cases of various types of foreign bodies in the different accessory nasal sinuses. The fact that only six times had any one reported more than one case caused me to assume that the finding of foreign bodies in the accessory nasal sinuses is not a frequent occurrence in the average rhinologist's practice, and I thought that perhaps a brief review of the literature covering the period that I have mentioned might be of sufficient interest to warrant my presenting it to you.

I regret that I have not a series of cases of my own to present to you, but, like almost all of those I found reported, my series is limited to one, but this case and a number of the others are sufficiently unusual to be of interest.

I have divided the cases into five groups, according to the nature of the foreign bodies, and I will present the case that came under my observation along with the group to which it belongs.

Group No. 1 consists of foreign bodies of dental origin, of which 17 observers reported 19 cases.

Group No. 2 consists of calculi, of which 2 observers reported 2 cases.

Group No. 3 consists of instruments and appliances, of which 33 observers reported 35 cases.

Group No. 4 consists of gun pieces and bullets, of which 40 observers reported 41 cases.

Group No. 5 consists of miscellaneous foreign bodies, of which 12 observers reported 13 cases.

It is in this last group that we find the more unusual and interesting cases.

In many instances like or similar foreign bodies have been found, and symptoms, treatment and results were not greatly different in these closely related cases; a brief summary of such groups is all that is intended. There are, however, some cases that are interesting because of their etiology, others because of their symptoms, and still others because of some peculiar incident, and of such cases more details will be attempted.

In Group No. 1, foreign bodies of dental origin, 19 cases reported by 17 observers, a summary of the group reveals that in five one or more teeth were found free in the maxillary antrum. No details are given concerning four of the cases, and in the other, reported by Herbert Tilley, a girl, 16 years old, had suffered the usual symptoms of empyema of the maxillary sinus for four months. A canine fossa operation was performed, removing much polypoid tissue and a molar tooth, which was lying free in the cavity. A rapid uneventful recovery followed.

In eight cases the foreign body consisted of a tooth or piece of tooth in the maxillary sinus following attempts at extraction. In one of these cases, reported by Arthur B. Duel, a piece of a root of a tooth was found embedded in a calculus the size of a pea. This resulted from a tooth being broken during extraction, nearly fifteen years previously, and the patient had suffered from maxillary sinus infection and poor health since shortly after the extraction had been performed. A good recovery was reported.

Sternfeld reports a case of spontaneous discharge of a piece of a tooth root from the maxillary sinus fourteen years after an infection of the sinus.

Sargnon reported a case in which a piece of dental root was expelled during lavage of the maxillary sinus, but states that

a canine fossa operation was necessary to cure the infected sinus.

J. M. Ingersoll, in 1903, reported a case which he regarded as a dentigerous cyst. The patient was four years old, and for several months had complained of right superior maxillary pain; the overlying tissues were inflamed, right naris obstructed and some exophthalmos of the right eye. Two right upper molars had not been erupted. Treatment did not relieve, and a canine fossæ operation was performed, resulting in the removal of two small molar teeth and much foul pus. He calls attention to the fact that dentigerous cysts usually occur from nonerupted permanent teeth and very rarely with the deciduous teeth.

C. S. Hawkes, in 1900, reported a case of dental cyst in a man 21 years old with very badly decayed teeth. A dentist was about to extract one of the upper lateral incisors when with slight pressure of the forceps it escaped upward and was lost. A probe passed upward into a cavity 2½ inches deep—this was thought to be the maxillary sinus. A canine fossæ operation disclosed it to be a dental cyst. He also calls attention to the difference between a dental cyst, which occurs in connection with dead or decayed permanent teeth, and a dentigerous cyst, which occurs from nonerupted teeth, usually of the permanent set.

Ralph J. Werner, in 1900, reported the case of a child, 3½ years old, in which two teeth were found in the maxillary sinus and a growth in the roof of the mouth that proved to be a giant celled sarcoma. The symptoms and course of the case were violent and severe, and terminated in death. Dr. Werner sent letters to 250 rhinologists, and from the replies he received he found that out of 3,409 cases of maxillary sinus disease 68 (or about 2 per cent) showed the presence of foreign body in the sinus. In only 30 (about 1 per cent) was the foreign body regarded as the cause of the disease. In 14 (7/11 of 1 per cent) the foreign body consisted of a tooth.

Berruyer and Laquerriere, in 1921, reported a case in which there was pain in the region of the left frontal sinus, with swelling and redness over the sinus area resembling a large furuncle. Roentgenography showed both frontal sinuses to be

clear, but indicated a foreign body in the left frontonasal duct. Examination identified the foreign body as a tooth in a dermoid cyst. Operation was advised, but the advice was not accepted and the case was lost sight of.

In Group No. 2 there were two cases in which calculi were found in the maxillary sinus.

N. B. Carson reported one case in 1913 and mentions it as a tumor of the sinus, in a man 67 years old. He found a calculus as large as the end of the little finger, the calculus being composed chiefly of calcium phosphate. His operation consisted in removal of the superior maxilla together with the eye.

O. Seidel reported, in 1919, a case of a woman, 21 years old, who for seven or eight years had experienced difficulty in breathing through the right side of the nose, and more recently the opposite side had become affected in like manner. No marked secretion of pus had been observed except for a short time following one severe cold, and this discharge ceased after treatment. A Denker radical operation was performed, and the calculus which was found was removed in pieces. No pus or secretion was found in the sinus, and its walls were reduced to the thickness of paper.

He states that calculi in the sinus may result from the presence of foreign bodies, from hardened pus in sinus infection, cholesteatoma, pseudocholesteatoma, and associated with malignant or benign tumors, and says that seven other cases of calculi in the maxillary sinus had been reported in the literature.

Group No. 3 consists of cases in which instruments and appliances or pieces of the same were found, and of this class 35 cases were reported by 33 observers.

There were two cases in which a tube or plug used following a canine fossa operation had been lost in the maxillary sinus. In nine, a drainage tube or plug used following an alveolar operation had escaped into the sinus.

Seven others were mentioned in which a drainage tube was found in the maxillary sinus, but the sources were not mentioned.

In one a piece of a glass syringe was recovered, that had been used at a previous operation.

In four, pieces of trochars or canulæ were found.

In four instances tampons were found.

In two, the foreign body was an obturator.

In two, a plug was removed, the character and source of which were not mentioned. In two other cases drains were found, their character, however, not being described.

In one, a piece of a dental prothesis was found, and in another a broken piece of a conchotome.

In practically all of this group the foreign body which was found in the sinus resulted from a previous operation upon the sinus, and there was little that was particularly noteworthy to distinguish any of them from the others except that in some instances the foreign body had remained in the sinus a long time, in one case eight years, in another, nine years, and in still another eighteen years. It was probably a factor in the continuance of the infections for which the prior operations had been performed.

The next group, Group No. 4, consists of gun pieces and bullets, and there were 41 cases reported by 40 observers. I believe these were all cases observed in civil life. The reports of war injuries that I found, in which bullets and shrapnell were removed from the sinuses, were brief and chiefly numerical reports, and are for that reason not included.

In seventeen cases of this group the foreign body found was a bullet, in ten in the maxillary sinus, in five cases in the sphenoid sinus, one in the ethmoid labyrinth and one in the frontal sinus.

Several gun wads were found in another case, and in another maxillary sinus there was found a piece of wood that had remained in the sinus for about a year. It had been a part of the charge used in a gun instead of bullet or bird shot.

Another case was that of a woman, 52 years old, in whose maxillary sinus two fragments of a discharge cap of a rifle were found.

Texier reported a case, cited by Razemon, in which, as the result of an explosion, a fragment of a rifle barrel lodged in the left maxillary sinus and had remained there two years without causing serious symptoms.

An interesting case in this group was reported in the Ophthalmic Record of April, 1905, by Dr. Harold Gifford of Omaha. The patient came to Dr. Gifford in 1903, and stated

that two years previously he had attempted to shoot a cat with an old fashioned musket, which exploded, knocking him senseless. The right eye was about destroyed and was enucleated. The recovery seemed good, except for occasional pain in the right side of the face and a purulent nasal discharge. Later this pain and discharge ceased, and pain and partial paralysis of the right arm and hand appeared. Through an opening in the lower nasal angle of the orbit a probe was passed and a metallic substance was felt. Nasal inspection showed a metallic substance in the upper outer wall of the right side of the nose. This piece of metal was removed through the orbit and found to be a part of the breech pin of the musket. It was one and a half inches long and weighed eleven drams. The following day the screw was found loose in the maxillary sinus and was also removed.

Dr. Gifford cites fifteen other similar breech pin accidents reported in the literature between 1842 and the time of his own report.

Group No. 5, the last to be mentioned in this paper, is comprised of miscellaneous foreign bodies.

Dr. Harry Kahn, in 1909, reported a case of a luetic, 50 years old, who had been salivated by treatment, all teeth lost except first and second upper left molars. His dental plate was loose, on account of shrinkage of the gums, and the patient devised the plan of a toothpick wedge between the plate and the first molar. This tooth became loosened and was extracted. The tooth socket failed to heal, and a purulent discharge from it persisted. The maxillary sinus was found to contain pus. It was curetted and a piece of a toothpick three-fourths of an inch long was taken out. Recovery followed at once.

Kahn, in 1906, reported the removal of a piece of straw three centimeters in length from a maxillary sinus.

Krebs, in 1907, reported two cases; one was a child 11 years old, from whose maxillary sinus he removed a piece of a rubber nipple of a milk bottle which he said had remained in the sinus at least seven years. The second was that of a man, 33 years old, in whose maxillary sinus he found a grain of corn which had been present there a little less than two years, with subsequent formation of a tumor mass. A cure

of the empyema resulted after extirpation of the tumor mass, the character of which is not mentioned.

Torrini, in 1917, tells of removing from a maxillary sinus a stone weighing 30 grains which had entered as a result of an explosion.

A similar case was reported by Kramer, in 1909. His patient was injured in an explosion twenty years before, at which time he lost some fingers and his right eye. Recently, on occasion of a fall in which his frontal region was injured, inflammation set in and a frontal fistula was established. Upon operation, a piece of coal, 1¼ cm. long and 4 mm. wide, was extracted from the right frontal sinus after following the tract of the fistula.

Schloffer, in 1913, reports a case which perhaps is a little outside the province of this paper. It was that of a man, 22 years old, who had sustained a gunshot wound, and a celluloid plate was implanted to take the place of the anterior wall of the frontal sinus. He says the plate had remained in place sixteen years and only recently had any swelling of the area been observed.

I. Moore, in 1917, reported the case of a woman, 67 years old, who has suffered from facial neuralgia for 25 years. A radiogram revealed a foreign body in the right maxillary sinus. A canine fossa operation was performed, and a piece of aluminum wire was found lying loose in the sinus. No pus was present and the mucosa of the sinus was perfectly healthful.

Thoret, in 1910, tells of a sword which entered a man's face, part of the blade being broken off and remaining in the maxillary sinus for four years, causing no other symptoms besides a conjunctivitis on that side. Then a purulent sinusitis began and the broken sword point was removed.

G. C. Hall, in 1919, had as a patient a man, 38 years old, upon whom he was operating for nasal sinus infection. He found in the ethmoid area a piece of knife blade, one and a quarter inch long and five-eighths of an inch broad. Twenty-two years previously the man had been stabbed, the point of entrance being the lower outer angle of the left orbit, the blade apparently passing beneath the eye and entering the ethmoid labyrinth back of the lacrimal bone.

John O. McReynolds, in 1907, reported the case of a man, 36 years old, who in February, 1903, while romping with a boy, was thrown forcibly against the lock of a screen door and sustained a wound along the infraorbital ridge. There was no injury to the eye, and the wound was sutured by the family physician, who did not apprehend any injury to the subjacent bony structures. The wound healed by first intention. There were not any subsequent symptoms of sinus infection. Two years after the accident the patient suffered for a few weeks from neuralgia of the face on the injured side, but this subsided. After the accident it had been discovered that the screen door lock was missing and search did not reveal it. Four years after the injury the patient found that two upper molars on the injured side had become so loose that he removed them with his fingers; a hard substance presented itself in the cavity where the teeth had been removed, and after considerable speculation as to the nature of this unsuspected intruder it also was removed by the patient's fingers and was found to be the iron bolt from the screen door lock, measuring three-eighths of an inch in thickness and one and five-eighths inch in length.

In 1900, Gulickers reported the case of a soldier who fell from a bicycle while smoking a pipe. For one and a half years after, a slight swelling persisted over the left molar region. There was a fistula where the first upper bicuspid had been extracted six years before. This fistula connected with the maxillary sinus; it was enlarged and a part of an amber mouthpiece of a pipe 5 cm. long 1.4 cm. wide was extracted from the sinus.

Barton H. Potts, in 1905, reported the case of a man suffering from influenza. During convalescence he mentioned a chronic discharge into the mouth. Examination revealed a fistula in the region of the canine fossa which connected with the maxillary sinus. Five months previously he had had influenza, with swelling and pain about the cheek on that side, which was relieved at the end of six days by a flow of pus into the mouth, which had persisted to a lesser degree since then. A canine fossa operation revealed a maxillary sinus full of pus and granulation tissue. The curette encountered a hard substance, which when removed proved to be a broken piece

of a hard rubber pipe stem 4.5 cm. long. The patient remembered that ten years before he had been thrown from a horse while smoking a pipe, and that he had spit a piece of the pipe stem from his mouth and had found the bowl of the pipe but not the other fragment and the stem, which apparently was the part now recovered from the sinus. It is noteworthy that for nine and a half years he had suffered no symptoms from the presence of this foreign body in the maxillary sinus.

The final case in this series is the one that came under my own observation in 1921. The patient was a man, 38 years old, of foreign birth, and spoke and claimed to understand so little English that the matter of procuring an accurate history from him was difficult. He was sent to me by his employer, from whom he was claiming compensation because of an alleged injury, saying that he threw a lump of lime into a box of mortar and some of the liquid mortar splashed into his face, and that a few days later a large swelling appeared under the left eye. He went to a physician, who opened this swelling, finding therein a large amount of pus. The incision failed to heal and there was a continuous discharge of pus from it.

It was something more than two months after this occurrence that the patient came under my observation. My examination at that time showed in the nasal half of the left lower eyelid the orifice of what appeared to be a discharging fistula, with only slight swelling and inflammation about it. The left eye was a little more prominent than the right and slightly below the center of the cornea was the scar of an old wound with an incarceration of the lower edge of the pupillary border of the iris in it. The vision of this eye was only equal to counting fingers at two feet distance; details of the fundus were not visible on account of the presence of vitreous opacities. In answer to questions regarding the condition of the eye itself, the patient said that when a small boy he fell while carrying an armload of hay and the left eye was wounded by a stiff spear of the hay.

Continuing the examination, it was found that a probe could be passed downward and backward through the fistula in the lower lid to the extent of about 2½ inches, and seemed to pass into the maxillary sinus. There was quite a free discharge

of pus into the left side of the nose. An X-ray picture at this time revealed a densely clouded left maxillary sinus, but did not reveal the presence of a foreign body. The Wassermann test was negative. An opening was made into the maxillary sinus through the middle fossæ of the nose, to temporarily facilitate drainage and permit daily lavage of the sinus. In a few days the fistula in the lower eyelid healed, only to break open again in a few days more. This healing and reopening occurred several times. The patient was then sent to the hospital and an opening for permanent drainage was made in the inferior nasal fossæ. However, the intermittent healing and reopening of the fistula in the eyelid continued, and by this time a considerable ectropion of the eyelid had occurred. Another X-ray picture was then made, with a lacrimal probe passed into the fistula, and in this picture, parallel to the course of the probe, in the maxillary sinus could be seen a tubular appearing object, about 1½ inches long and a quarter of an inch in width and appearing of about the same density as the surrounding bony structures. With this knowledge that the maxillary sinus contained some kind of foreign body, a Caldwell-Luc operation was performed. When considerable granulation and polypoid tissue had been curetted away there could be seen in the posterior part of the sinus cavity, extending diagonally upward and forward, a dark cylindrical object, which was wedged tightly in place and loosened with considerable difficulty and, to my surprise, proved upon removal to be a horn pipe stem or mouthpiece, as it is sometimes called. Furthermore, the threaded connection by which such a mouthpiece is screwed onto the main part of the pipe stem was present and unbroken. This detail further complicates the mystery of how this pipe stem got into the sinus as, manifestly, it was not broken off from the pipe, and the patient never admitted to me any knowledge of how it came there. After this operation upon the sinus and the removal of the pipe stem the fistula in the eyelid quickly healed and the purulent discharge from the sinus had about subsided when the patient left my care, about three weeks after the operation.

I concluded that the reason the first X-ray picture did not reveal the presence of this foreign body was because the pipe stem, being made from horn, was of only a little more density,

so far as X-ray penetrability was concerned, that the surrounding bone, and the deep shadows cast by the contained pus and granulation tissue obliterated it from view.

In conclusion, let me briefly mention—

First.—The unquestionable value of the radiogram in diagnosis of nasal sinus disease.

Second.—That these reported cases have shown that a foreign body may in some instances be tolerated in a sinus for many years without producing suppuration.

Third.—The evident preference for the Caldwell-Luc type of operation in these cases.

Fourth.—That many maxillary sinus infections are of dental origin.

Fifth.—That facial neuralgic pains were almost the only symptoms in some of these cases.

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SOCIETY PROCEEDINGS.

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY.

Meeting of Monday, March 1, 1926.

THE PRESIDENT, DR. HARRY L. POLLOCK, IN THE CHAIR.

CASE PRESENTATIONS.

Temporal Lobe Abscess.

BY SAMUEL SALINGER, M. D.

A boy, aged 14, came into the hospital on January 13, apparently very ill. He gave a history of headaches and projectile vomiting, which had persisted for several months. He had had a radical mastoid operation nine months previously. Examination per the meatus revealed the mastoid cavity filled with what appeared to be cholesteatomatous tissue, which it was impossible to remove. Papilledema was present on both sides, and there was marked contraction of both fields for form and color. There were no focal symptoms except hallucinations of smell; the patient said he seemed to be smelling ether continuously. There was a strongly positive Oppenheim and a suggestive Babinski reflex of the contralateral side.

The old mastoid wound was opened, and it was found that what was thought to be a cholesteatoma was brain tissue which had collapsed into the radical cavity. They later found that the dura had been exposed and incised at the previous operation. The necrotic brain tissue was followed inward and forward, and at a depth of one and a half inches an abscess was encountered. Three ounces of pus escaped under pressure. A tube was placed in the cavity but slipped out about a week later, and the boy had a recurrence of his symptoms. The tube was replaced, but again slipped out, and on this occasion there was great difficulty in getting it back because the capsule of the abscess was very dense and offered resistance to the penetrating tube.

The tube had been in place continuously and the cavity was still draining moderately. Frequent irrigations were necessary

to keep the tube open. The boy was up and around and had no complaint except an occasional subjective smell of ether, of which he first complained on admission to the hospital. They anticipated some difficulty in collapsing the cavity and thought there would doubtless be a discharging fistula until this was accomplished.

DISCUSSION.

DR. JOSEPH BECK said that many men who had treated these abscesses had been troubled by having the tube slip out and called attention to the plan used by an associate of Dr. Mosher of Boston. This man had reported fifteen cases in which they had used a funnel made of wire mesh, which was fastened to the surrounding skin. As the granulation tissue gradually formed around the fnnnel it was gradually removed.

DR. EDWIN MCGINNIS said he believed Dr. Mosher got this idea from the British Expeditionary Forces. They used this method of drainage, leaving the funnel in for six weeks and then letting it come out by itself.

DR. SALINGER (closing) thanked Dr. Beck for his suggestion, but thought it would not be feasible at the present time to change the method of drainage, at least until the fistulous tract leading into the cavity was well walled off.

A Case of Laryngectomy.

BY C. F. YERGER, M. D.

A man, aged 46, entered the Cook County Hospital on January 28, 1926, because of embarrassed respiration, which was due to partial closure of the respiratory tract. An emergency tracheotomy was performed, and, upon further examination by indirect laryngoscopy, a growth was discovered that involved one-half of the larynx. At about this time Dr. Pollock presented a patient before the Society who had had a somewhat similar condition, and the removed specimen showed that the carcinomatous growth had extended to the other side subglottically. Dr. Yerger's case was thought to be a good one for laryngectomy, and when the larynx was removed it was found that the growth involved both sides, as well as the first ring, and possibly the second, of the trachea below the cricoid cartilage.

The laryngectomy was performed on February 8th, in the usual manner, and the incision had completely healed. He had not thought it wise to remove any of the trachea, because of the possibility of tension on the skin, and the trachea was sutured in situ, with the idea of treating the carcinomatous area later by deep roentgen ray therapy or radium. The operation was performed under nerve blocking anesthesia, according to the method of M. L. Harris. The anesthesia was complete, and Dr. Yerger recommended the method very highly as being better than the infiltration with novocain. This method consists in making the posterior injection at the posterior border of the sternocleidomastoid muscle, just a little above the middle, being careful not to get the needle into the external jugular vein. When sure that no blood has been secured in the syringe the solution is injected below the deep fascia, which reaches the superficial cervical plexus and causes anesthesia of the neck. The opposite side is treated in the same manner. The superior laryngeal nerve is blocked very readily by getting the hyoid and injecting about 10 cc. of novocain superficially to infiltrate the superior laryngeal. When the superior laryngeal nerves and plexus are blocked one can proceed without infiltrating the line of incision. There is no pain except in cutting the mucosa of the pharynx, and this can be avoided by injecting the mucosa before incising the pharynx.

A catheter was placed through the nose following the operation. They had made a mistake in not cutting off the closed tip at the end, as they experienced considerable difficulty in getting the liquid diet through one week later because of obstruction in the lateral opening by accumulated food.

DISCUSSION.

Dr. G. W. Boot congratulated Dr. Yerger on the outcome in his case, because he still had a fistula present in a case which had been operated on a month before, but he thought the patient would be cured of the carcinoma.

Dr. Alfred Lewy asked Dr. Boot if the recurrent growth in the larynx had been examined histologically.

Dr. Boot replied that it had not as yet.

DR. OTTO STEIN said he had two cases in which he had performed a laryngofissure for carcinoma, with subsequent apparent recurrence, but he thought these recurrent growths were sometimes nothing but granulomas, or healing tissue. Both of his patients had survived for several years. He thought Dr. Lewy's question was very pertinent, and asked Dr. Yerger if there was any extralaryngeal glandular involvement, and whether any glands were excised at the time of operation. He agreed with Dr. Yerger that a local anesthetic was ideal in these cases.

DR. SALINGER stated that the difficulty of recognizing the extent of the carcinomatous involvement below the glottis had been discussed by many, particularly Pancoast and Mackenty. Indirect laryngoscopy and frequently even direct laryngoscopy will fail to disclose wide subglottic involvement unless the vocal cords are separated to permit direct inspection.

DR. JOSEPH C. BECK thought Dr. Yerger's patient, who had such excellent results up to the present, was in danger of a recurrence if the Doctor pinned his faith to the roentgen ray and radium. He recommended instead that he use electrocoagulation for destroying the growth.

Dr. Beck had just performed a second operation on the patient whom he presented at the February meeting. Two weeks before, he had done a complete laryngofissure with the aid of the radio knife, the operation being done very rapidly and easily. He did a gross incision, exposed the larynx, cutting the cartilage and everything, except a piece of tissue for microscopic examination, with this knife. He wished to have a piece of tissue for examination that would not be affected by the heat from the radio knife. The growth proved to be malignant, so two weeks later he opened the larynx, which was found to be involved on both sides, with no involvement of the glandular structure outside.

He thought the point raised by Dr. Stein was very important. The low glands are much more important than those above, and in those cases there is not much to be expected from the roentgen ray or radium.

DR. BOOT said that as the trachea is very movable, and practically all of it can be excised when necessary, he thought that

in this case Dr. Yerger would have done better if he had taken off the upper ring or two that were involved at the time of operation.

Dr. Harry L. Pollock presented a Mackenty apparatus of the type being worn by the patient who was presented at the February meeting, and said that four of their patients are now wearing these very successfully.

He congratulated both Dr. Yerger and Dr. Boot on their laryngectomies. In regard to laryngofissure, he recalled a patient who was presented in 1925, who had a growth that was localized on one side. He took away the cricoid cartilage and removed the growth. The wound healed very rapidly, but at the end of three or four months there was an apparent recurrence. He delayed doing anything for a time, thinking it was a granuloma or a large polyp, but as it increased in size he removed a piece by laryngoscopy and then did a laryngectomy. He considered this a good method of procedure where the growth is localized in the region of the cord. By direct laryngoscopy, and separating the cords, one can obtain a fairly good idea of the extent of the growth, and it can be removed by window resection or laryngectomy. He had performed this operation on four or five patients, who were alive after five years. He called attention to the recent report of a Southern physician, who performed a laryngectomy for a supposed carcinoma of the larynx, without biopsy, and later found the larynx was tuberculous. Dr. Pollock believed there was no danger in doing a biopsy, and that it made the operation much safer.

Dr. Yerger (closing), in reply to Dr. Stein, said that he was surprised not to find any lymphatic involvement in such an extensive growth, and no glands were removed. The growth looked typical of carcinoma and no biopsy was done. The Wassermann reaction was negative, sputum and roentgenogram of chest were negative for tuberculosis, and he was convinced that the diagnosis of carcinoma was correct.

For feeding he thought the Rehfuss duodenal tube through the nose was much better than the ordinary catheter.

In addition to the local anesthetic they gave ¼ grain of morphin and 1/150 scopolamin one hour before the operation.

Unusual Eye and Systemic Complications of Nasal Obstruction.

By George J. Musgrave, M. D.

The first case reported was that of a man, aged 32, who had first consulted him, about three years ago, regarding the correction of a divergent strabismus. He gave a history of having been "shell shocked" during the war. He was in bed for a week and following that had diplopia with divergent strabismus. On examination he found normal vision and no ocular paralysis. To complete the examination for contributory causes he placed a pledget of cotton saturated with a 10 per cent solution of cocain at the anterior portion of the middle turbinate bone, on account of a deviated septum. To his amazement the eye became straight and had remained straight up to the present, with no other therapeutic measures.

The second case was that of a woman, aged 28, who gave a history of an epileptic attack at the first menstrual period, and the attacks had persisted since that time. She passed through the usual treatment of internists, but two years before coming to Chicago nausea, vomiting and severe suboccipital headaches developed. Because of these symptoms she was referred to Dr. B. W. Sippy, who made a thorough examination and decided that the same influence that caused the headache and convulsions caused the gastric symptoms. She was referred to Dr. Frank Allport because of a convergent strabismus, and was later referred to Dr. Musgrave for a tonsillectomy. She complained of having lost her sense of smell. There was some evidence of sphenoid and ethmoid trouble, and a complete exenteration was performed. With the first touch of cocain the patient went into an epileptic convulsion, so he changed immediately to a general anesthetic. She made a complete recovery, had had no further convulsions, the convergent strabismus had disappeared and three years had passed since the operation.

The third patient had been operated on for a mastoid infection and was presented to emphasize the fact that such operation is sometimes required, even when the typical symptoms of mastoid abscess are lacking. Dr. Musgrave had seen many patients go on to complete deafness because the attending physician refused to operate for otorrhea without the classical

mastoid symptoms. This patient's hearing was restored to normal and he had no further trouble following operation, the sole indication being a persistent bilateral otorrhea with deafness nine months after scarlet fever.

DISCUSSION.

DR. A. A. HAYDEN said that he had recently been informed that there was no mastoid work done at the contagious hospital. The man who told him this concluded that inasmuch as all the patients recovered from their contagious disorder, or whatever caused the mastoid infection, there were many unnecessary mastoid operations performed in Chicago.

DR. G. W. BOOT said he had recently been asked to get a patient into the County Hospital who had just been discharged from quarantine for scarlet fever, and had developed a mastoiditis and whom private hospitals refused to admit. There is great difficulty in getting any scarlet fever cases with a mastoid infection into private hospitals, and Dr. Boot thought some provision should be made whereby this could be done.

DR. ROBERT SONNENSCHEIN believed some of the hospitals went on the principle that exclusion is not necessary after the quarantine period of scarlatina has ended, provided streptococci are not found in the secretion. He recently had a case which he took up with the superintendent of the Michael Reese Hospital, and, after consultation with the attending physicians, it was decided that there was no danger in admitting the patient. The child was removed to the Sarah Morris Memorial Hospital, and he was convinced that there was no danger, when the quarantine had been raised, in admitting them to the hospitals.

Retropharyngeal Abscess With Erosion of Normally Placed Internal Carotid.

BY T. C. GALLOWAY, M. D.

The patient, an 11-year-old girl, had been ill six days when first seen in consultation, February 15, and was complaining of pain on left side of throat referred to the ear, with some difficulty in swallowing. There presented behind the left faucial pillar a beefy swelling, about 2 by 3 cm., only slightly

raised. When next seen, four days later, there was a rounded pole swelling, about 3 by 5 cm. in diameter, which fluctuated. This was opened, and about 25 cc. of thick greenish pus evacuated. There was almost no bleeding. Twelve hours later there was a sudden hemorrhage, with the loss of about 500 cc. of blood, which stopped after the nurse applied pressure with cotton. Thromboplastin and fibrinogen were given for two days, then calcium lactate by mouth. The patient was removed to the hospital and did fairly well, having a moderate bloody stained pus discharge. Five days later 50 cc. of blood escaped suddenly. On account of temperature, the wound was gently reopened with forceps three days after the operation. On February 28th he started to make a more lateral opening with scissors, but desisted on account of the resistant feel of the swelling.

At 10:30 p. m., on February 28, again suddenly, between 300 and 500 cc. of blood were lost. The patient was very weak and almost pulseless; 100 cc. of blood had been given intramuscularly in the morning, but she was taken to the operating room and given 450 cc. of uncitrated blood by the syringe method. A throat set and neck set were ready. As the last syringe was emptied the patient spat out a mouthful of blood, and upon looking at the throat a stream of blood about 15 mm. wide could be seen. Pressure and packing did not control it, nor did pressure of the carotid against the carotid tubercle by an assistant. Just after ligating the internal carotid the patient stopped breathing from exsanguination and aspiration of the blood, which the Beck suction apparatus was unable to remove fast enough.

At autopsy, Dr. J. Lisle Williams found that bleeding from this region would have to come from (1) the ascending pharyngeal, a rather small artery; (2) anomalous branches of the external carotid, or (3) from erosion of the internal carotid, which has no branches in its cervical portion.

From the history of this case and the one presented by Dr. Boot in February, and from the consideration of the blood supply of this region, it seemed to Dr. Galloway that any sudden and profuse hemorrhage associated with retropharyngeal

abscess is an indication for immediate ligation of the internal or common carotid.

The autopsy report was as follows:

"When the tissues of the neck are dissected free, an abscess cavity filled with blood and purulent material opens. It lies behind and to the left of the esophagus, and extends downward to the level of the roof of the thorax. It contains necrotic material, fluid and clotted blood. The arterial wall of this abscess cavity is extended backward and upward on the left side, where it is in contact with the bony structure of the pharynx, and here it is eroded through the wall of the internal carotid artery. The channel of the vessel at this point takes a sudden turn as it enters the base of the skull cavity, with a bulge inward. The aperture through which the hemorrhage came is apparently 3 mm. in the greatest diameter."

DISCUSSION.

DR. OTTO STEIN believed these cases were not very uncommon and thought Dr. Galloway's last remark should be kept in mind by everyone. When such a large amount of blood was lost in connection with a laryngeal abscess one should be led to do an immediate ligation of the internal carotid artery.

DR. GALLOWAY (closing) stated that statistics showed that the operative mortality of ligation of the internal or common carotid is between 2 and 3 per cent, and cerebral softening or other severe damage occurs in about 25 per cent. With the poor circulation and pronounced anemia there would have been great danger from ligation in his case, but he thought this should have been done, perhaps earlier.

Cranial Injury Followed by Involvement of Labyrinth and Cochlea.

BY C. F. YERGER, M. D.

A man, aged 39, porter, who had been married twenty years and had four healthy children, came to the Illinois Eye and Ear Infirmary on December 15, 1923, with the history that two days previously he had been struck on the head with a billiard cue. He stated that he was unconscious for a few minutes, followed by vertigo, vomiting, disturbed vision and ataxia.

There was exudation of bloody serum from the right ear. Deafness in the right ear was noticed immediately after the accident and this had persisted. The vestibular symptoms were present for a period of four hours, with no recurrence since then. Examination of the right membrana tympani disclosed a rupture which was plugged by blood clot.

On February 24, 1926, he returned to the dispensary on account of deafness and tinnitus involving the right ear. The functional test showed the findings of nerve deafness. The left ear was normal.

On March 8, 1926, the vestibular tests showed on rotation, with the head erect, a nystagmus of 7 seconds' duration when rotated toward the right and of 9 seconds' duration when rotated toward the left. With head back, rotation towards the right produced a nystagmus of 9 seconds and rotation towards the left of 14 seconds. The caloric test was normal on the left but not on the right side; with the head erect, no nystagmus resulted, but with the head back there was a distinct nystagmus. There was no spontaneous nystagmus or past pointing. The induced past pointing and falling tests were normal. He gave a history of a doubtful chancre before marriage, but had had several negative Wassermann reactions.

DR. YERGER thought this was undoubtedly a case of skull fracture, which occurred when the man was hit on the head with a billiard cue two years ago, when he became unconscious and bled from the nose. He did not know whether it was a basal fracture or not, but the man had involvement of the labyrinth and of the cochlea. He had stuporous symptoms, was very dizzy, nauseated and vomited, and probably had nystagmus. The significant thing was that two years afterward he had complete nerve deafness. There was involvement of the organ of Corti, and the vestibular branch was functioning. He had regained some of the vestibular function, but had lost the cochlear function. About 25 per cent of the basal skull fracture cases have involvement of the labyrinth, which is due to the hemorrhage into the membranous labyrinth. A sudden, very loud noise will sometimes produce the same symptoms. Dr. Yerger believed that the pars petrosa may have been fractured, in spite of the fact that the man apparently had a slight injury.

Unusual Sinus Roentgenogram Obtained by Oral Rhinoscopy.

By A. A. Hayden, M. D.

The patient was a man, aged 53, with an extensive facial disfigurement. Three years ago a right upper wisdom tooth was removed with very little difficulty. The patient had a history of tuberculosis on his father's side of the family and also admitted having had syphilis thirty years ago, for which he was treated. Following the tooth extraction an induration of the right cheek developed, which persisted for several weeks, when a fistula opened into the mouth. He then consulted a physician in Waukegan, who collected a specimen from the fistula, sent it to a Chicago laboratory for diagnosis and the report was carcinoma. The patient then received roentgenotherapy and later, in Chicago, radium was applied. At the expiration of three months he was informed that the treatment had not been effective and he would have to have a resection of the malignant tissue in his mouth. This was done in two stages, at intervals of about five months. All of his teeth were removed, and the upper part of his jaw sloughed out. The patient was satisfied with the result obtained, but was now looking for plastic surgery to repair the disfigurement. He was not Dr. Hayden's patient and he did not know whether or not the diagnosis of carcinoma was correct.

Dr. Hayden then exhibited pictures from the case of a woman, aged 30, who consulted him because of right antrum disease. The first molar had been extracted several months before, and following this a fistula formed and the patient was greatly distressed because food and liquids trickled through her nose. This case offered an excellent opportunity to use lipiodol in the examination of the sinuses. Dr. Hayden did not know whether this preparation would prove ideal for use in the sinuses, but thought that where it showed a very clear cut outline of the antrum it might be of value. It could be injected through the eustachian tube and the outline secured in this way.

DISCUSSION.

Dr. Alfred Lewy asked if there was any reaction or local irritation from the lipiodol.

DR. JOSEPH C. BECK believed the injection of lipiodol would be of no value unless it was put in something which would fill out the cavity of the antrum, as it is too thick and oily to do this satisfactorily alone. It has an advantage over bismuth, because it is nonirritating, and it has proved of great value in examination of the bronchial tree. He thought if it could be incorporated in vaselin so that it would fill out the sinus cavities it might be of value.

DR. HAYDEN (closing) said he realized that the antrum cavity was not completely filled out in his case, but had thought this was due to his faulty technic. The needle he used did not fit into the dental root very snugly and therefore he could not carry enough pressure to cause complete filling of the cavity. It should be injected with a large needle. He believed that lipiodol was prepared by Merck & Company in this country and put on the market under the name of "Lipidin."

Paper: "The Saccus Endolymphaticus and Its Relation to Labyrinthine Muscle Tonus."*

BY HECTOR G. LAREAU, M. D.

Paper: "Primary Osteomyelitis of the Mastoid Bone (Traumatic): Report of Case and Review of Literature."†

BY MYRON E. KAHN, M. D.

Paper: "Foreign Bodies in the Accessory Nasal Sinuses."‡

BY M. BRYED WILSON, M. D.

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*See page 1032. †See page 1246. ‡See page 1259.

CHICAGO LARYNGOLOGICAL AND OTOLOGICAL SOCIETY.

Meeting of Monday, April 5, 1926.

THE VICE-PRESIDENT, DR. C. F. YERGER, IN THE CHAIR.

Paper: "Interpretation of Speech Sounds by Means of Their Tactual Correlates."*

BY ROBERT H. GAULT, PH. D.

DISCUSSION.

DR. J. GORDON WILSON said Dr. Gault had introduced us into a new field of investigation. It was well to keep in mind that he approached this subject from the standpoint of the psychologist; and rightly so, for it is a psychologic problem. While he does not neglect or underestimate the physical problems which require to be solved, it is the mental problem which dominates and must dominate this investigation. The fundamental question Dr. Gault is endeavoring to answer is: Can the sense of touch stimulated by the human voice arouse in the mind word patterns with intrinsic meanings analogous to those normally conveyed by the voice through the auditory sense? He is not trying to get sound through. He is trying to get to the apperceptive mechanism in the brain touch vibrations of such a nature that they will awaken sensations corresponding to the sensations awakened by sounds. To Dr. Wilson the realization of the storage of these concepts in memory did not seem so difficult a conception as the one he had just stated.

We all know that movements and attitudes of the lips and mouth can be translated into mental concepts of what the voice is saying and thus sight can act as a fairly efficient substitute in many cases. It can also frame the lips and mouth in a corresponding manner and so produce the first step in a serviceable vocalization. Can touch also give mental concepts? If it can

*See page 1050.

it offers greater potentialities, for touch and hearing are closer in their physical properties than are hearing and sight. No one believes that touch or sight can ever rank as the equivalents of hearing. But if touch can aid in the conveyance of speech vibrations, even if it be only to supplement the assistance which lip reading now gives, or to shorten the period required for training, we shall have advanced beyond the stage we now have attained and added immeasurable advantages to the deaf, both educational and pleasurable.

In discussing this subject we must discard the words sound and hearing and allow our thoughts to dwell on what is fundamental and common to both—(1) the external physical property of vibrations, and (2) the possibility of such an education by touch. Can the sense of touch, aided by a physical instrument such as Dr. Gault uses, be made so acute and so discriminating that it can be cultivated or educated to distinguish these fine shades of complex vibrations which go to make up speech? We know what touch can do for the blind, but for the deaf it must be vastly more acute to be useful. But it would be a mistake to argue that it cannot be hoped for. The linking up of the cerebral associations of touch and hearing is something new, and he would be hasty who would predict the outcome. Still, when one recalls the complexity of speech vibrations, as seen in the graphic curves we all know, and when we are mindful of the elaborate mechanism which nature has laid down in the cochlea to aid the separation of vibration differences, and contrast these with the relative simplicity of the touch mechanism, we may well doubt if touch can ever be an effective substitute, even with an excessive amount of training. But this is a long way from saying that there is no future for this work, that it is an interesting piece of psychologic investigation which offers no practical outcome. It appeared to Dr. Wilson that even in this early stage of the work there were many apparent advantages. He referred to only two of these:

(1) He believed it would shorten the time now required to make the deaf proficient in lip reading and make vocalization more effective. Efficient lip reading and vocalization is not only shaping the lips in a particular attitude, it is the vibration of the lips and surrounding structures when in this attitude.

Dr. Gault's apparatus will give a realization of what vibration is and the kind required, not otherwise obtainable.

(2) It promises advantages in the perception of musical rhythms and all the pleasures associated with these. The association of hearing and the muscular adjustment of the body in the inner ear has possibly a deeper significance than is ordinarily believed. Who can have watched deafmutes gliding gracefully through a waltz or two-step in perfect time to the varying music without realizing that the tactual sense is subconsciously at work? He had no time to elaborate this, but thought it not a long leap from here to the musical enjoyment of rhythm. In the music of dancing it is the accentuated beat which dominates the dance, and it is the accentuated beat which will best stimulate the tactile sense. One would like to know if deafmutes can dance such complex dances as the tango or such rhythmic dances as folk dances if in these the beat is sufficiently accentuated or can be made so by Dr. Gault's mechanism. In music it is the regular rhythm dominated by the beat which is essential. One might compare it to the swell of the ocean, each swell broken by smaller ripples which serve to magnify its grandeur. At present this swell can be picked up by the tactual organs. If the smaller ripples can be so magnified by Dr. Gault's mechanism as to be perceived, what potentialities lie here for the enjoyment of music. In this field, Professor Gault had presented fascinating glimpses of new mental activities, with possibilities of assistance to those deprived of one of the most important senses. Otologists are deeply interested in this work and most desirous of seeing it carried farther. Dr. Wilson hoped he would elaborate what he had outlined and explore still further the possibilities of touch as an aid to hearing.

Mr. F. W. Kranz, Ph. D., Riverbank Laboratories, Geneva, Ill. (by invitation), said that he had been interested in Prof. Gault's work ever since he had seen the first notices of the earlier portions of it, some two or three years ago. Hearing in the usual sense, as well as in the sense considered in Prof. Gault's work, consists in the detection and differentiation of sound vibrations in the air, from the voice or other vibratory source. If the differentiation to be made were merely as to the

presence or absence of sound, it would be simple and could be accomplished either by means of the sense of hearing or the sense of touch with the use of available apparatus.

It is sometimes assumed that if a deaf person could have a sound of sufficient intensity to listen to, he could hear and understand, but this is not the case. The reason lies partially in the ear itself. The principles are now known for the construction of instruments to produce sounds as loud as one may desire, as intense, in fact, as the air is capable of transmitting, for the air will not transmit too loud a sound without the wave breaking over in somewhat an analogous fashion to large waves on the ocean. If a very loud sound is presented to an ear which has a deficiency somewhere along in its transmission system, with the idea of getting enough energy through this barrier to properly activate the mechanism beyond the barrier, then the portion of the system transversed before the barrier is reached will be called upon to transmit energies far greater than it was designed for, and this will result in distortion of the sound quality similar to the distortion occurring in a vacuum tube amplifier when the input is greater than that for which the vacuum tube was made.

Pure tones differ only in frequency and intensity, and the usual sounds are complex tones, which are simply combinations of pure tones. Whether a complex tone is pleasing or not depends upon the frequency relations of the various component tones. The ear is capable of detecting sounds of different frequencies, from 20 to 20,000 cycles per second. The amplitude of a sound at 2,000 cycles per second, which the ear is just capable of perceiving, is about one one-billionth of an inch, which is much smaller than any movement which can be detected by the sense of touch. Changes of 10 per cent in the intensity of sounds of ordinary loudness can be noticed by the ear, as can also changes of about 1 per cent in the pitch. The sense of touch will detect changes in pressure of about 25 per cent.

Probably the differentiations made by the tactile sense in Prof. Gault's work are those of rather gross changes in amplitude. Thus, if a person has his fingers on Prof. Gault's telephone receiver, which is being actuated by a 500 cycle current,

it does not seem probable that he will follow the position of the diaphragm in its excursions occurring in one five-hundredth of a second, but what will probably be detected will be the changes in what may be called the envelope of the motion—that is, the variations in the maximum positions of deflection of the diaphragm, which variations will probably occupy a time of something of the order of a second rather than one five-hundredths of a second. Sentences would probably be differentiated by the sequences of changes of amplitude, and as a sentence has a longer sequence than a word, the possibilities of variation are greater, and so it should be much easier to distinguish between sentences than between words. Single sounds, as the vowel sounds, are even shorter than average words, and so are more difficult to differentiate.

If the diaphragm of the receiver should have a pronounced resonance at a particular frequency, there would be a greater amplitude response for sounds at near this frequency than at other frequencies, and so something of a pitch differentiation would be possible because of this dependent amplitude effect. However, with the type of receiver used by Prof. Gault the resonance is apparently not at all marked. With a given amount of energy the amplitude is greater for the lower frequencies, and this is probably of some assistance to the observer in his differentiations.

Mr. Kranz thought that a further refinement of Prof. Gault's apparatus might be made which would give a spatial differentiation of the received frequencies. If four receivers were used, with the resonant frequencies of the diaphragms suitably separated, and a finger were held on each of the four diaphragms, one would obtain a spatial differentiation of the frequencies which, in combination with the amplitude discriminations now being used, should aid greatly in distinguishing between various sound or sound combinations. Of course, any number of such different receivers could be used, up to the number of digits available. This should accomplish directly and with much better control what Dr. Goldstein does in having deaf children place their five fingers on a membrane over the end of a megaphone into which he is speaking. There is probably a spatial distribution of the sound energy over the

surface of the diaphragm and this is picked up by the five fingers. A large diaphragm would probably differentiate between sounds by a change in the vibratory pattern over its surface.

He thought that Prof. Gault was working principally with semimutes and partially with totally deaf subjects. The semimutes have some remnant of hearing left and can make some differentiations of sound with the ear. It seemed to Mr. Kranz that for the purpose of teaching these people to imitate normal speech, which he thought was one of the important objects of Prof. Gault's work, the use of strong amplification, if necessary, on the ears for auditory stimulation would have some advantages. It would give the rhythm which they got from the tactile sense and also a little help in identification from their pitch sensitivity, although the quality of the sound as a whole might not be correctly perceived. The totally deaf can, however, only be reached through the sense of touch.

He asked how far Prof. Gault had gone with the appreciation of music. This would involve delicate discriminations of both frequencies and amplitudes, which seemed rather beyond the possibilities of the sense of touch. Probably a person could be brought to a higher state of enjoyment of the tempo of music through the sense of touch, but it would seem that that would be about all that could be done.

DR. PAUL SABINE, Riverbank Laboratories, Geneva, Ill. (by invitation), stated that he was greatly impressed with the results that Dr. Gault had achieved in his unique experiments. Aside from the scientific significance of these results, the thing that occurred to him most forcibly in listening to Prof. Gault's paper was the fundamental difference between the physicist's and the psychologist's method of attack on such a problem. Considering how complex a thing, from the physical point of view, even the simplest vowel sound is, how minute are the physical differences between the vowel "ah" and the vowel "aw," for example, and how unlikely it is that such fine distinctions could be perceived by so coarse a perceptive mechanism as the sense of touch, the physicist would be apt to throw up his hands and say "it cannot be done." If he did find courage to attack the problem at all, he would start with the

simplest possible case, from the physical point of view, as, for example, pitch discrimination between two pure tones. The psychologist, on the other hand, starts on the broad basis of adapting an organism to its environment. He says to the deaf-mute, "You have one sense left, the sense of touch. Let us see what we can do in the way of substituting that for the auditory sense of normal individuals." He does not start with the physically simplest case; he starts at the very center of the thing, produces the sense impressions in all their physical complexity and leaves it to the creative faculty of the nervous system and the mind to convert them into the symbols of ideas.

This difference in the method of approach was striking, and he had been tremendously stimulated in his own thinking by the evidence of the results the professor had achieved. In the light of such work he felt that it takes considerable courage to say anything is impossible. He agreed with Dr. Wilson that the work, both as a psychologic experiment and as a practical means of the alleviation of deafness, was tremendously worth while.

Dr. Frank G. Bruner, Director of Special Schools (by invitation), expressed his great interest in and admiration for Prof. Gault's work. He was not certain that the deaf sensed real sounds through the skin, but rather something like what a normal individual would experience were he to employ the Morse code on the end of the fingers. He called attention to the fact that the appreciation of one's own voice when speaking is made up of a number of elements, namely, bone conduction and with it certain motor and tactile experiences as well as auditory. He had been greatly surprised upon talking into a dictaphone and then listening to his own voice to find that it did not sound at all natural. He thought it a well known fact that those who are afflicted with speech defects often are not aware of their defects, which is due to the fact that so much of the hearing of one's own voice is made up of a muscular sense and bone conduction, which do not come through the ear. Hence one's own speech defects are not so displeasing to oneself as to others.

They are employing the tactile sound appreciation at the Alexander G. Bell school for the deaf, where they are teach-

ing totally deaf children to sing. This is done by having the music score placed on the blackboard before the pupils, while the music is played on the piano, with the children standing with both hands resting on the piano. They had been astonished to note how easily they learn to appreciate and sing simple tunes. He thought this was in line with the experiment upon which Prof. Gault is working, and that the children were sensing through the sense of touch cycle differences, the different tones having different intensity values.

He called attention to some experiments he had conducted to determine hearing difference of different primitive peoples using a telephonic apparatus.

The amount of energy required for normal hearing is infinitely small, ranging in different normal individuals from six to twenty-one hundred-millionths of an erg. To make a difference which could be sensed by the skin, this would have to be multiplied from 10,000 to 20,000 times, and this makes a sound so intense the air will not conduct it.

Dr. Bruner thought that what the children were appreciating in Prof. Gault's work was not a difference in the intensity of the sound, but cycle differences. He was greatly interested in the work, from a practical standpoint, because of its relation to teaching speech to the deaf in the Chicago schools, of which he has charge. They are able to teach intelligible speech at present to only about one in three deaf children—i. e., develop them to a point where they can speak and read the speech of others readily. If it were possible to perfect a device by the use of which a large percentage of the deaf could be taught to speak and understand speech, it would be a wonderful thing in their education.

Dr. Bruner asked if the subjects were given two sentences which Prof. Gault had mentioned, "I am going to the city" and "He said he was tired," whether he could combine parts of those sentences—"He said he was going to the city," and have them accomplish the feat of understanding.

Dr. Elmer L. Kenyon thought the natural basis of comparison for such work was the development of speech in the

normal individual. All individuals start life without the ability of speech or of understanding speech. The sounds of speech enter the ear of the child as words and combinations of words and are transmitted to the brain as corresponding sensations. From the memory of these sensations in the auditory word center, the child essays to play sounds on his own speech making machine. In order to do this, he must analyze words from sentences and sounds from words. This necessity for culling out of words their constituent sounds is the most difficult part of the process of learning to talk. The child finds his greatest aid in the constant comparison of the results of his own efforts with the memories he holds of the same sound as produced by others. This process of differentiation requires six or eight years for its completion. It was interesting to compare the time which a child requires for learning to talk with the time which Prof. Gault's pupils used in learning the tactile speech. Dr. Gaul't pupils, comparatively, had taken hardly more than a month out of the six years required by the individual to learn to talk, and yet had secured splendid results in this short period. Dr. Kenyon thought this was one of the most hopeful indications.

He believed undoubtedly that in the child learning to talk, the stimulation to make the differentiations is brought about largely through the compulsion of the child to play these sounds on his own speech machine. When children learning to talk fail to develop speech normally, the trouble, speaking generally, does not lie in the auditory word area, nor in the motor word area, nor in the peripheral speech area, but in the intelligence area, in the process of differentiating the sensations which come to the auditory word center. It is the difficulty of word analysis that causes the child's trouble. Dr. Kenyon did not know whether it was possible for an individual to carry the apparatus of Prof. Gault around with him, but thought this would be the thing to do, if possible, for he would thus get much experience in analyzing the sensations produced by the speech of others and at the same time could compare such sensations with those produced by his own voice. Thus he might be able to improve his own voice and speech.

In almost everything which the child has to learn in the world care is taken to teach him, whatever the subject may be. The one thing which occurs without instruction is the development of speech in the young child. He is given words and sentences with any degree of carelessness, and he has to differentiate the words and then the elementary sounds from the words, and until he knows these sounds and is able to place them rightly in any word, he cannot talk normally. Dr. Kenyon considered this a very unintelligent method and thought one should give the child individual sounds and words slowly spoken, thus reducing the period of learning to talk by 50 per cent. If children are not learning to talk well they are taught individual sounds and single words separately. He thought it was expecting a great deal for Prof. Gault to expect an individual in a short time to differentiate words and sentences before he had learned to differentiate individual sounds. Not only vowels, but consonants also, should be practiced individually.

Dr. Kenyon asked Prof. Gault whether there was any hope for the differentiation between whispered sounds by these individuals. Since one-quarter of the sounds of English speech are whispered sounds, if so large a factor of speech cannot be differentiated, the procedure would be greatly handicapped.

Dr. Alfred Lewy asked if Prof. Gault thought that people beyond middle age, who were not benefited by the usual mechanical aids to hearing, could be helped in a practical way by this method.

Prof. Gault said he could not answer Dr. Dewy's question. He had never worked with such a subject, but from the observation he had made he thought this might be possible. He had a patient who was deafened at the age of sixteen and who is now twenty-seven, and he thought that he got on more rapidly than the others.

Replying to Dr. Bruner's question, Prof. Gault said that in the last academic year they tried to accomplish this. He worked first with more than twenty subjects until they learned to identify well ten sentences made up of monosyllabic words, and then made up a list of ten new sentences using the same words, and found that the subjects learned the second list in

approximately half the time necessary for the first. He thought this might be because they had become somewhat acquainted with the movement of speech.

Replying to Dr. Kenyon, he said he had not made any systematic experiments with different consonant sounds, but knew that his students could feel "F" and "St," and the like, in the instrument, although he did not know how accurately they could distinguish them.

As to the possibility of employing the localization on the skin, he said that the new instrument which the Bell Laboratories are making is on the order of a sound filter, having five different receivers, one for each finger.

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